Service Manual

(Model 30410)

Groundsmaster® 4000–D

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 4000–D.

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE, AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book to insert the Operator's Manuals and Parts Catalogs for your machine. Replacement Operator's Manuals and Parts Catalogs are available on the internet at www.Toro.com.

The Toro Company reserves the right to change product specifications or this publication without notice.

This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A **NOTE** will give general information about the correct operation, maintenance, service, testing, or repair of the machine.

IMPORTANT: The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.

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Safety

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General Safety Instructions

The GROUNDSMASTER 4000-D was tested and certified by TORO for compliance with the B71.4-1999 specifications of the American National Standards Institute. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

To reduce the potential for injury or death, comply with the following safety instructions.

Before Operating

1. Read and understand the contents of the Operator's Manual before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. A replacement Operator's Manual is available on the Internet at www.Toro.com or by sending the complete model and serial number to:

   The Toro Company
   Attn. Technical Publications
   8111 Lyndale Avenue South
   Bloomington, Minnesota 55420−1196

2. Keep all shields, safety devices, and decals in place. If a shield, safety device, or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting units are DISENGAGED.

4. Since diesel fuel is highly flammable, handle it carefully:

   A. Use an approved fuel container.

   B. Do not remove fuel tank cap while engine is hot or running.

   C. Do not smoke while handling fuel.

   D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill.

   E. Wipe up any spilled fuel.

While Operating

1. Sit on the seat when starting and operating the machine.

2. Before starting the engine:

   A. Engage the parking brake.

   B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).

   C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust until machine does not move when traction pedal is released.

3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

4. Do not touch engine, muffler or exhaust pipe while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

5. Before getting off the seat:

   A. Ensure that traction pedal is in neutral.

   B. Set parking brake.

   C. Disengage cutting units and wait for blades to stop.

   D. Stop engine and remove key from switch.

   E. Toro recommends that anytime the machine is parked (short or long term), the cutting units should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of cutting units accidentally lowering to the ground.

   F. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments, lower decks, stop engine, set parking brake, and remove key from the switch.

2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

3. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.

4. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.

5. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

6. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting units to the ground.

7. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.

8. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.

9. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting units and other moving parts. Keep bystanders away.

10. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed.

11. Shut engine off before checking or adding oil to the crankcase.

12. Disconnect battery before servicing the machine. Disconnect negative cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive cable first and negative cable last.

13. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes, and clothing. Protect your face, eyes, and clothing when working with a battery.

14. Battery gases can explode. Keep cigarettes, sparks, and flames away from the battery.

15. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.

16. When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions).

Jacking Instructions

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

Jacking the Front End (Fig. 1)

1. Set parking brake and chock both rear tires to prevent the machine from moving.

2. Position jack securely under the frame, just to the inside of the front tire.

3. Position jack stands or hardwood blocks under the frame as close to the wheels as possible to support the machine.

Jacking the Rear End (Fig. 2)

1. Place jack securely under the center of rear axle.

2. Chock both front tires. Jack rear of machine off the ground.

3. Use jack stands or blocks under the axle to support the machine.

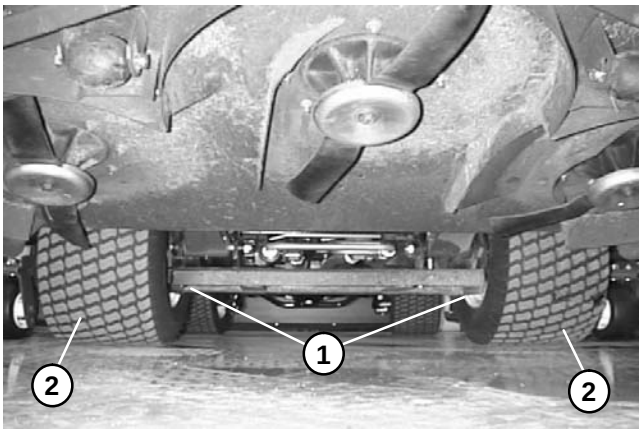

Figure 1

1. Frame jacking point **2. Front tire**

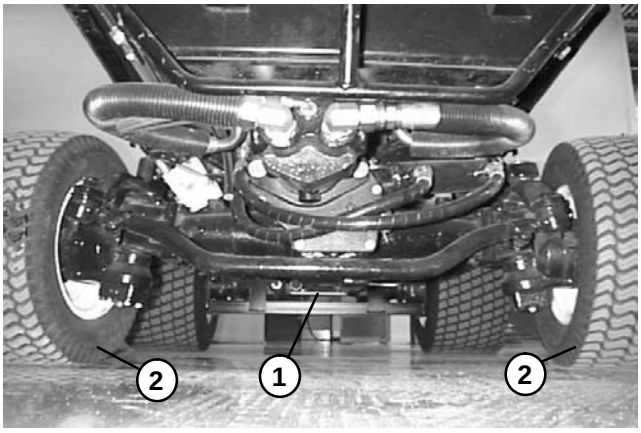

Figure 2

1. Rear axle jacking point **2. Rear tire**

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the Groundsmaster 4000−D. If any decal becomes illegible or damaged, install a new decal. Part numbers are listed in your Parts Catalog.

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Product Records and Maintenance

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Product Records

Insert Operator's Manual and Parts Catalog for your Groundsmaster 4000−D at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for the Groundsmaster 4000−D are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.09375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	**5/8**	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	**3/4**	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.938	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	**7/8**	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	**1**	1.000	— 25.400

1 mm = 0.03937 in. **0.001 in. = 0.0254 mm**

U.S.to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subract 32° 2. Multiply by 5/9

Torque Specifications

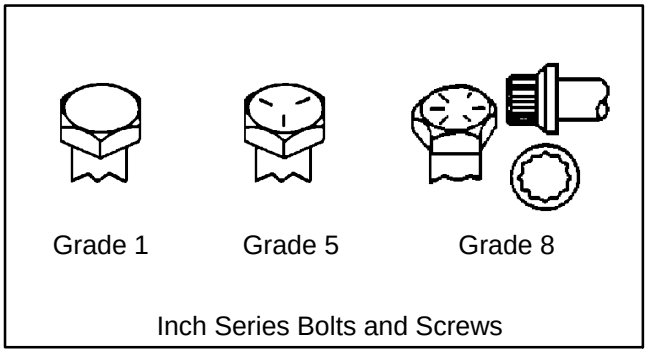
Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (e.g. Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature, hardness of the surface underneath the fastener's head, or similar condition which affects the installation.

As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

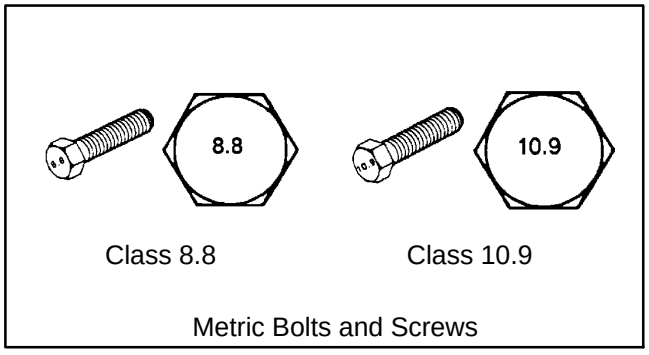
The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification



Inch Series Bolts and Screws

Figure 1



Metric Bolts and Screws

Figure 2

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5, & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in−lb	**in−lb**	**N−cm**	**in−lb**	**N−cm**	**in−lb**	**N−cm**
# 6 − 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	170 ± 20	23 ± 2	260 ± 20
# 6 − 40 UNF				17 ± 2	190 ± 20	25 ± 2	280 ± 20
# 8 − 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	330 ± 30	41 ± 4	460 ± 45
# 8 − 36 UNF				31 ± 3	350 ± 30	43 ± 4	485 ± 45
# 10 − 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 4	475 ± 45	60 ± 6	675 ± 70
# 10 − 32 UNF				48 ± 4	540 ± 45	68 ± 6	765 ± 70
1/4 − 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1125 ± 100	140 ± 15	1580 ± 170
1/4 − 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 10	1300 ± 100	160 ± 15	1800 ± 170
5/16 − 18 UNC	115 ± 15	105 ± 17	1186 ± 169	200 ± 25	2250 ± 280	300 ± 30	3390 ± 340
5/16 − 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2540 ± 280	325 ± 30	3670 ± 340
	ft−lb	**ft−lb**	**N−m**	**ft−lb**	**N−m**	**ft−lb**	**N−m**
3/8 − 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 4	58 ± 5
3/8 − 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 3	47 ± 4	50 ± 4	68 ± 5
7/16 − 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 − 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 5	75 ± 7	77 ± 7	104 ± 9
1/2 − 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 10	142 ± 14
1/2 − 20 UNF	32 ± 3	53 ± 7	72 ± 9	85 ± 8	115 ± 11	120 ± 10	163 ± 14
5/8 − 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 20	285 ± 27
5/8 − 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 15	230 ± 20	240 ± 20	325 ± 27
3/4 − 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 25	359 ± 34	375 ± 35	508 ± 47
3/4 − 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 25	407 ± 34	420 ± 35	569 ± 47
7/8 − 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 − 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 45	644 ± 61	660 ± 60	895 ± 81

Note: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

Note: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

Note: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners)

Thread Size	Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 5 in−lb	640 ± 60 N−cm	78 ± 7 in−lb	885 ± 80 N−cm
M6 X 1.0	96 ± 9 in−lb	1018 ± 100 N−cm	133 ± 13 in−lb	1500 ± 150 N−cm
M8 X 1.25	19 ± 2 ft−lb	26 ± 3 N−m	27 ± 2 ft−lb	36 ± 3 N−m
M10 X 1.5	38 ± 4 ft−lb	52 ± 5 N−m	53 ± 5 ft−lb	72 ± 7 N−m
M12 X 1.75	66 ± 7 ft−lb	90 ± 10 N−m	92 ± 9 ft−lb	125 ± 12 N−m
M16 X 2.0	166 ± 15 ft−lb	225 ± 20 N−m	229 ± 22 ft−lb	310 ± 30 N−m
M20 X 2.5	325 ± 33 ft−lb	440 ± 45 N−m	450 ± 37 ft−lb	610 ± 50 N−m

Note: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

Note: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

Note: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 − 20 UNC	140 ± 20 in−lb	73 ± 12 in−lb
5/16 − 18 UNC	215 ± 35 in−lb	145 ± 20 in−lb
3/8 − 16 UNC	35 ± 10 ft−lb	18 ± 3 ft−lb
1/2 − 13 UNC	75 ± 15 ft−lb	50 ± 10 ft−lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 − 20 UNF Grade 5	65 ± 10 ft−lb	88 ± 14 N−m
1/2 − 20 UNF Grade 5	80 ± 10 ft−lb	108 ± 14 N−m
M12 X 1.25 Class 8.8	80 ± 10 ft−lb	108 ± 14 N−m
M12 X 1.5 Class 8.8	80 ± 10 ft−lb	108 ± 14 N−m

** For steel wheels and non−lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23, or Type F	
Thread Size	**Baseline Torque***
No. 6 − 32 UNC	20 ± 5 in−lb
No. 8 − 32 UNC	30 ± 5 in−lb
No. 10 − 24 UNC	38 ± 7 in−lb
1/4 − 20 UNC	85 ± 15 in−lb
5/16 − 18 UNC	110 ± 20 in−lb
3/8 − 16 UNC	200 ± 100 in−lb

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque*
	Type A	Type B	
No. 6	18	20	20 ± 5 in−lb
No. 8	15	18	30 ± 5 in−lb
No. 10	12	16	38 ± 7 in−lb
No. 12	11	14	85 ± 15 in−lb

* Hole size, material strength, material thickness & finish must be considered when determining specific torque values. All torque values are based on non−lubricated fasteners.

Conversion Factors

in−lb X 11.2985 = N−cm
ft−lb X 1.3558 = N−m

N−cm X 0.08851 = in−lb
N−m X 0.7376 = ft−lb

Chapter 3

Kubota Diesel Engine

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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, V2003−T SERIES

General Information

This Chapter gives information about specifications and repair of the diesel engine used in the Groundsmaster 4000−D.

General maintenance procedures are described in your Operator's Manual. Information on engine troubleshooting, testing, disassembly and reassembly is identified in the Kubota Workshop Manual, Diesel Engine, V2003−T that is included at the end of this section.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Kubota Workshop Manual, Diesel Engine, V2003−T. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Kubota engines are supplied through your Authorized Toro Distributor. If no parts list is available, be prepared to provide your distributor with the Toro model and serial number.

Stopping the Engine

IMPORTANT: Before stopping the engine after mowing or full load operation, cool the turbo-charger by allowing the engine to idle at low speed for 5 minutes. Failure to do so may lead to turbo-charger trouble.

Specifications

Item	Description
Make / Designation	Kubota, 4−Cycle, 4 Cylinder, Water Cooled, Turbocharged, Diesel Engine
Horse Power	58 HP (43.3 kW) @ 2600 RPM
Bore mm (in.)	83.0 (3.27)
Stroke mm (in.)	92.4 (3.64)
Total Displacement cc (cu. in.)	1999 (122.12)
Firing Order	1−3−4−2
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity liters (U.S. gallons)	72 (19.0)
Fuel Injection Pump	Bosch Type Mini Pump (PFR)
Governor	Centrifugal Mechanical
Low Idle (no load)	1450 $\pm$ 50 RPM
High Idle (no load)	2730 $\pm$ 30 RPM
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Compression Ratio	22.0:1
Injection Nozzle	Bosch Throttle Type
Engine Oil	SAE 10W30 or 10W40 Detergent (API CD, or higher)
Oil Pump	Trochoid Type
Crankcase Oil Capacity liters (U.S. quarts)	7.6 (8.0) with Filter
Starter	12 VDC, 1.4 kW
Alternator/Regulator	12 VDC, 40 AMP
Coolant Capacity liters (U.S. quarts)	10.4 (11) with 0.9 (1.0) Reservoir
Engine Dry Weight kilograms (U.S. pounds)	184 (406)

Adjustments

Run Solenoid

1. When ignition switch is in the RUN position, the run solenoid should energize and position the fuel stop lever to within 1/16” (1.6 mm) of stop on the injection pump.

2. If adjustment is needed, loosen lock nut and rotate the threaded end of the swivel until the lever is properly positioned.

3. Tighten lock nut. Recheck adjustment.

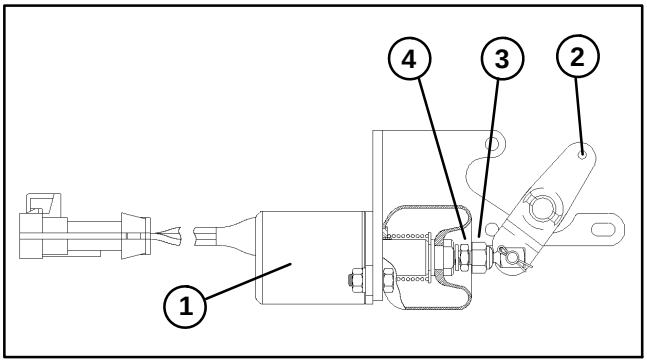

Figure 1

1. **Run solenoid**
2. **Solenoid lever (run)**
3. **Swivel**
4. **Lock nut**

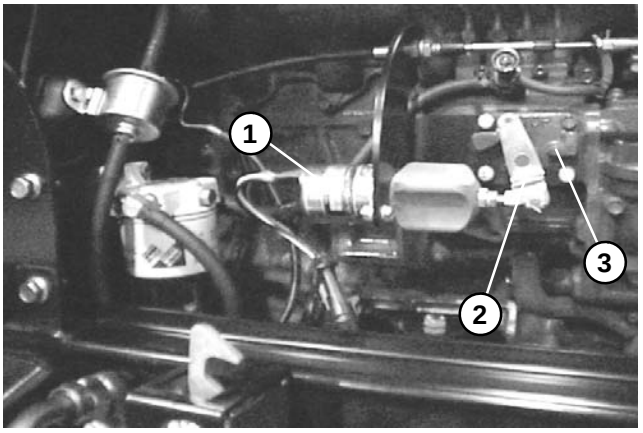

Figure 2

1. **Run solenoid**
2. **Solenoid lever (off)**
3. **Injection pump stop**

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Air Filter System

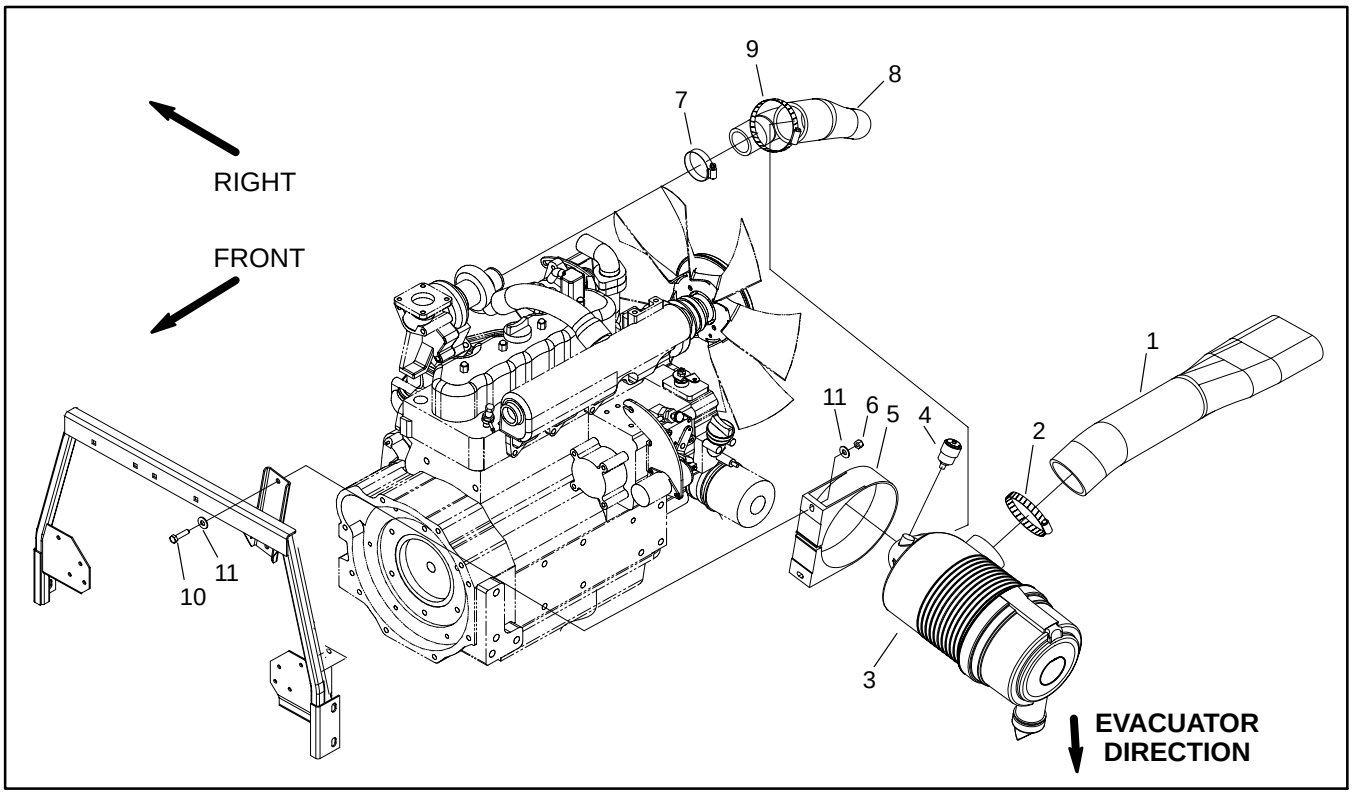

Figure 3

1. **Air cleaner hose**
2. **Hose clamp**
3. **Air cleaner assembly**
4. **Indicator**
5. **Air cleaner strap**
6. **Lock nut**
7. **Hose clamp**
8. **Air cleaner hose**
9. **Hose clamp**
10. **Cap screw**
11. **Flat washer**

Removal

1. Remove air cleaner components as needed using Figure 3 as a guide.

Installation

IMPORTANT: Any leaks in the air filter system will cause serious engine damage. Make sure daily that all air cleaner components are in good condition and are properly secured during reassembly.

1. Reassemble air cleaner system using Figure 3 as a guide.

2. When installing air cleaner hose (8) between air cleaner and turbo−charger (Fig. 4):

A. Make sure that hose does not contact engine valve cover. To modify clearance, move and/or rotate air cleaner body in air cleaner strap. Verify that tabs in strap mesh fully with slots in air cleaner body.

B. Position hose to allow maximum clearance between air cleaner hose and muffler bracket.

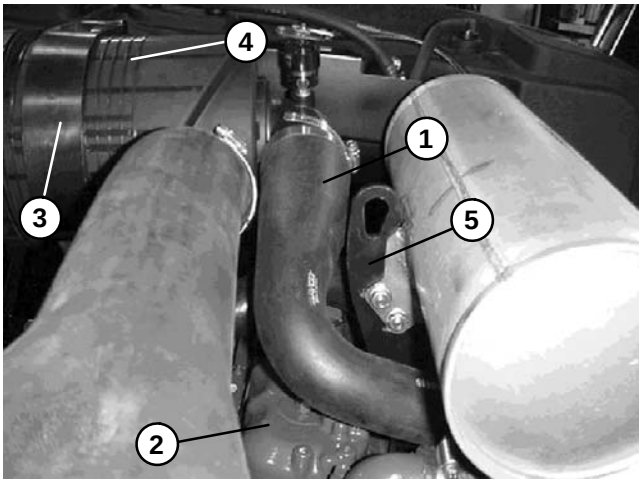

Figure 4

1. **Air cleaner hose**
2. **Engine valve cover**
3. **Air cleaner strap**
4. **Air cleaner body**
5. **Muffler bracket**

Exhaust System

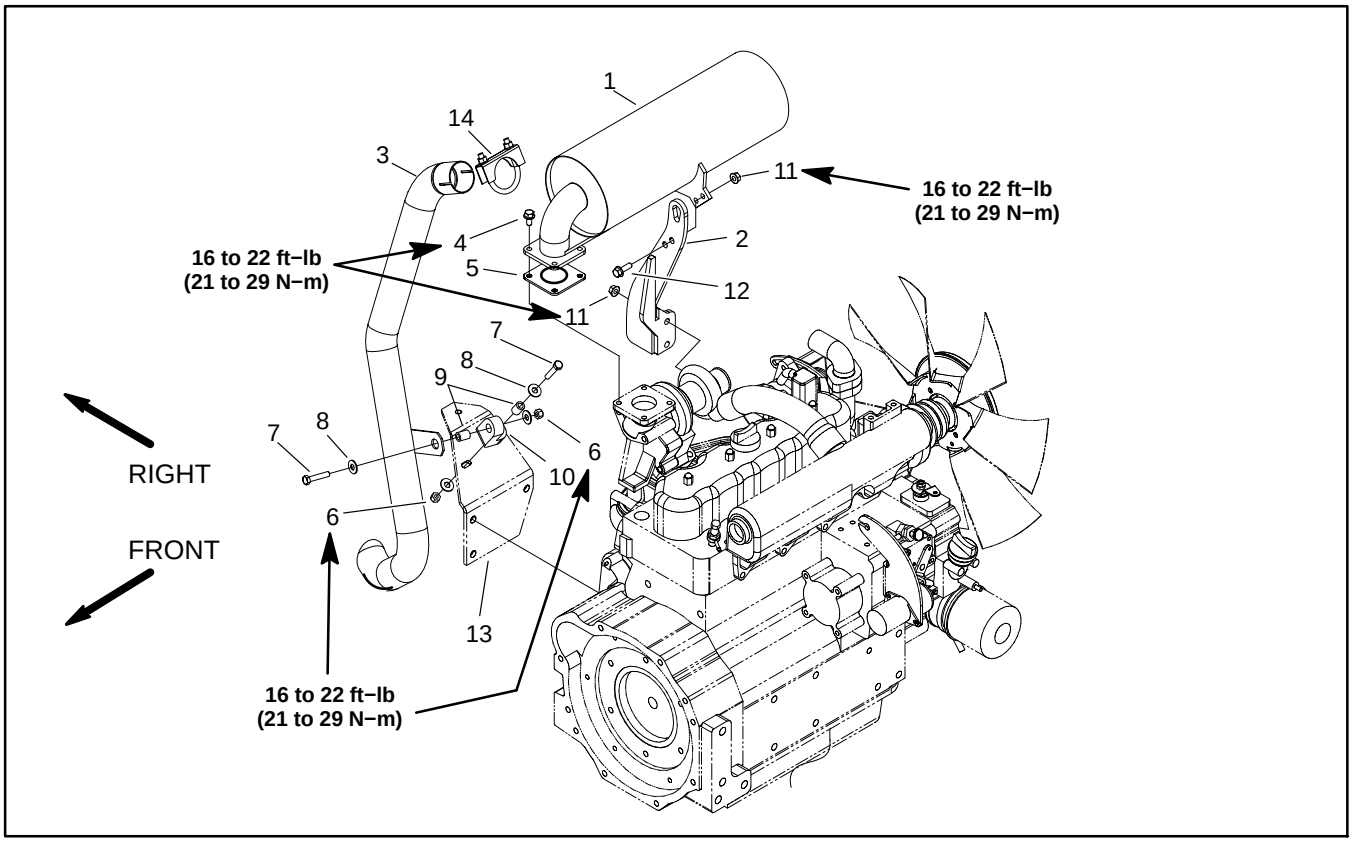

Figure 5

1. **Muffler**
2. **Muffler bracket**
3. **Exhaust pipe**
4. **Flange head screw**
5. **Exhaust gasket**
6. **Lock nut**
7. **Cap screw**
8. **Flat washer**
9. **Spacer**
10. **Rubber hanger**
11. **Flange nut**
12. **Flange head screw**
13. **Engine mount**
14. **Muffler clamp**

Removal

CAUTION

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the muffler.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove muffler and/or muffler bracket from the engine as necessary using Figure 5 as a guide.

Installation

IMPORTANT: If exhaust studs were removed from engine cylinder head, thoroughly clean threads in head and apply Loctite #277 (or equivalent) to stud threads before installing studs into head.

Note: Make sure muffler flange and exhaust manifold sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Install **new** gasket if original gasket is damaged or torn.

IMPORTANT: Failure to follow the suggested muffler fastener sequence may result in premature muffler failure.

2. Install muffler and/or muffler bracket to the engine using Figure 5 as a guide. Hand tighten and then torque the following fasteners from 16 to 22 ft−lb (21 to 29 N−m) in the sequence listed (Fig. 6):

A. Locknuts used on rubber hanger cap screws.

B. Flange nuts that secure muffler to muffler bracket.

C. Flange head screws that secure muffler flange to engine.

D. Flange nuts that secure muffler bracket to engine.

3. Tailpipe should have equal clearance between frame and engine after installation.

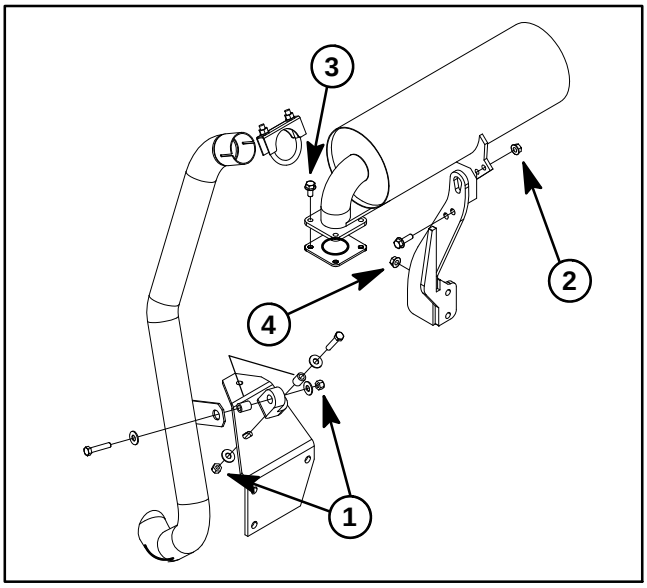

Figure 6

Fuel System

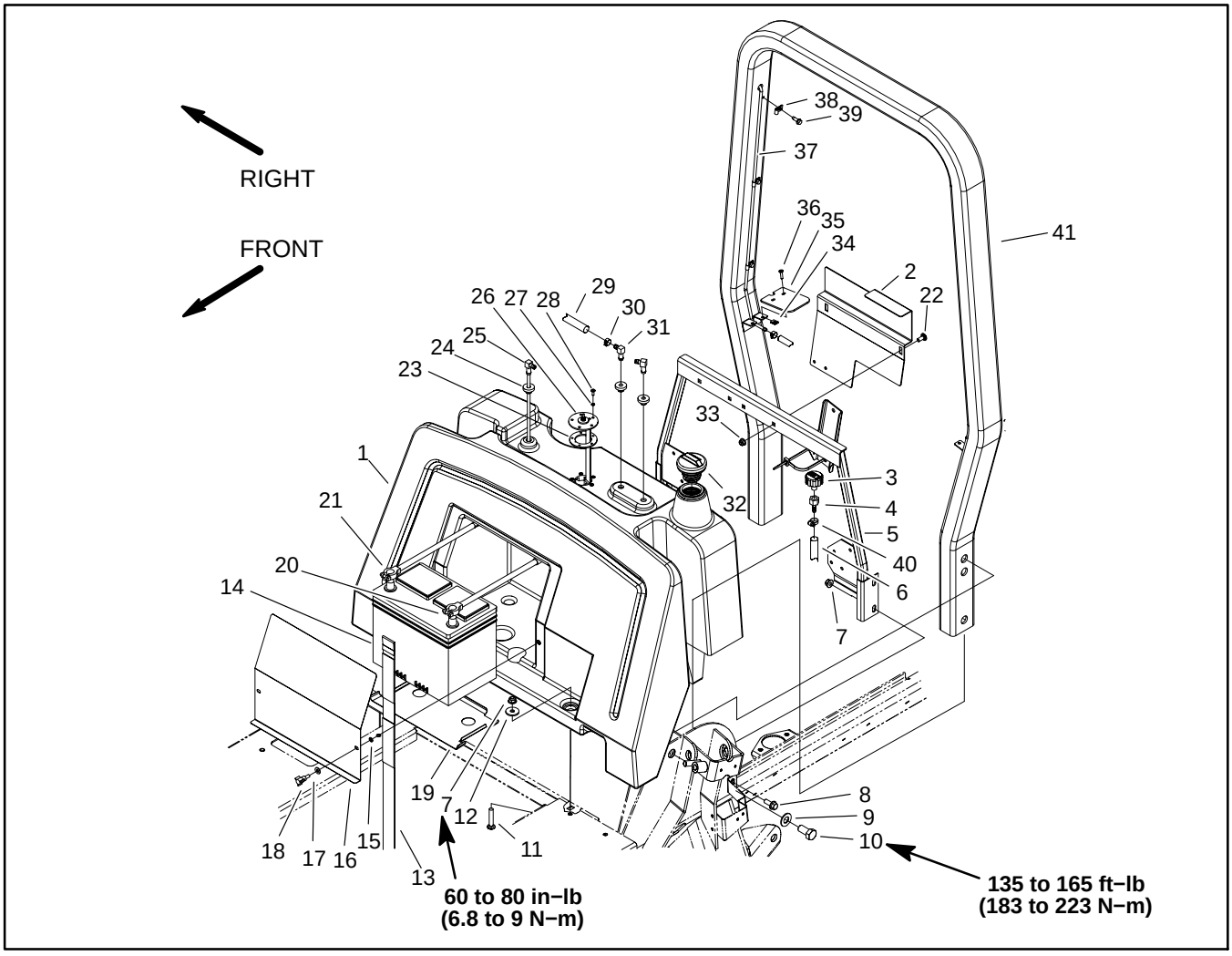

Figure 7

1. **Fuel tank**
2. **Fuel tank bracket**
3. **Air breather**
4. **Female hose barb**
5. **Tank support assembly**
6. **Fuel hose**
7. **Locking flange nut**
8. **Cap screw**
9. **Flat washer**
10. **Cap screw**
11. **Carriage screw**
12. **Washer**
13. **Battery strap**
14. **Battery**
15. **Retaining ring**
16. **Battery cover**
17. **Flat washer**
18. **Knob**
19. **Battery plate**
20. **Negative cable**
21. **Positive cable**
22. **Carriage screw**
23. **Gasket**
24. **Bushing**
25. **Stand pipe**
26. **Fuel sender**
27. **Lock washer**
28. **Phillips head screw**
29. **Fuel hose**
30. **Hose clamp**
31. **Elbow fitting**
32. **Fuel cap**
33. **Locking flange nut**
34. **Speed nut**
35. **Tank cover**
36. **Phillips head screw**
37. **Vent tube**
38. **Insulated clip**
39. **Washer head screw**
40. **Hose clamp**
41. **ROPS assembly**

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety−approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

Check Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the Operator's Manual. Check lines for deterioration, damage, leaking, or loose connections. Replace hoses, clamps, and connections as necessary.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the Operator's Manual. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

To clean fuel tank, flush tank out with clean diesel fuel. Make sure tank is free of contaminates and debris.

Fuel Tank Removal (Fig. 7)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Raise seat and hood.

3. Remove battery cover and strap. Disconnect negative battery cable first and then positive battery cable. Remove battery from machine.

4. Use a fuel transfer pump to remove fuel from the fuel tank and into a suitable container.

5. Disconnect electrical wiring from the sending unit.

6. Disconnect fuel hose from the standpipe and venting hoses from elbow fittings in top of tank.

7. Remove phillips head screws that secure two (2) tank covers to ROPS assembly. Remove tank covers.

8. Remove fuel tank using Figure 7 as a guide.

Fuel Tank Installation

1. Install fuel tank using Figure 7 as a guide.

   A. Torque two locking flange nuts that secure the fuel tank to the frame from 60 to 80 in−lb (7 to 9 N−m).

2. Install two (2) tank covers to ROPS assembly.

3. Connect fuel hose to the standpipe and venting hoses to the elbow fittings.

4. Connect electrical wiring to the sending unit.

   A. Connect white wire to the center terminal and black wire to any of the screws that secure the fuel sender to the fuel tank.

   B. Apply skin−over grease to the wire terminal connections.

CAUTION

Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

5. Position battery in machine. Connect positive battery cable first and then negative battery cable. Install battery strap and cover.

6. Lower seat and hood.

7. Fill fuel tank (see Operator's Manual).

Radiator

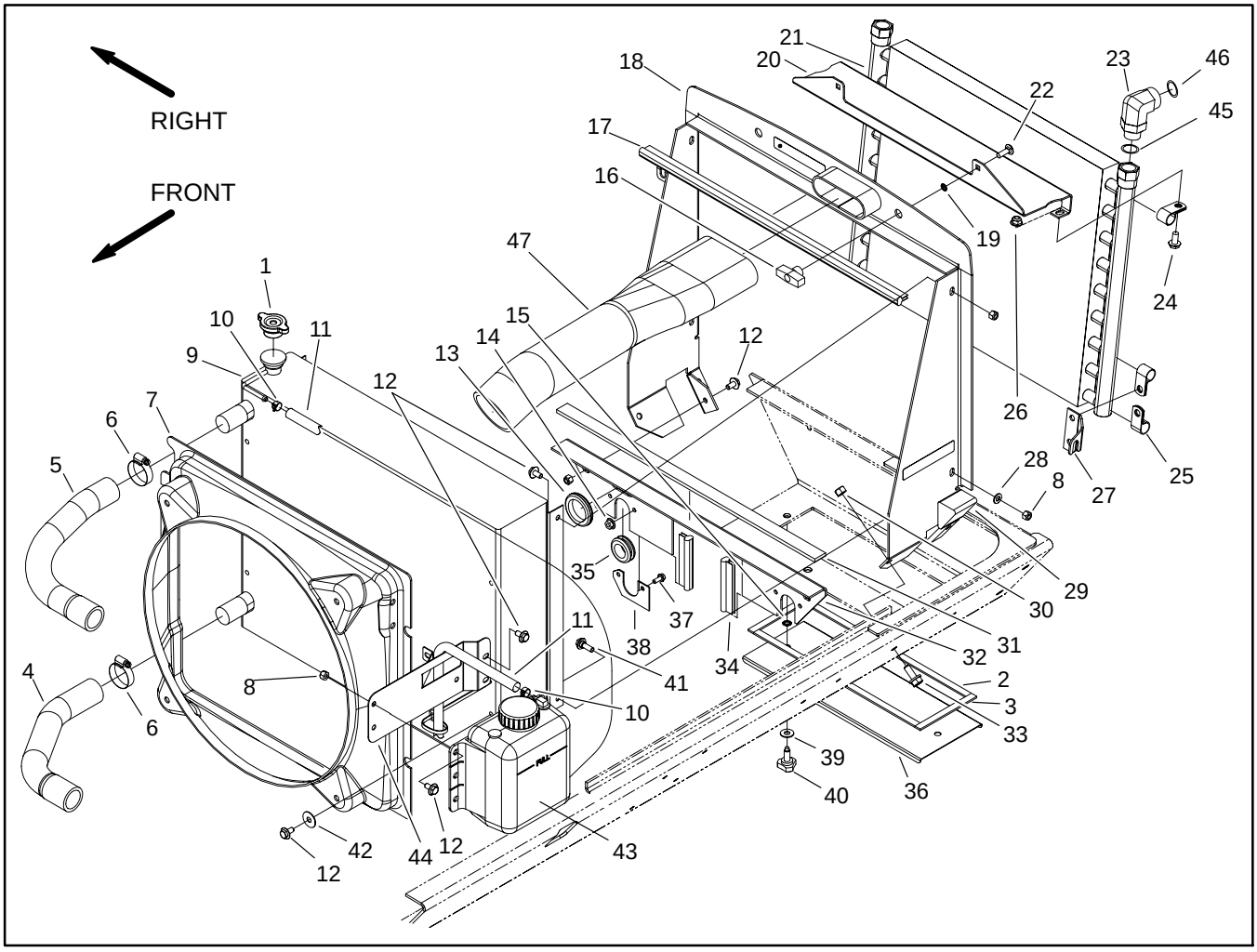

Figure 8

1. **Radiator cap**
2. **Foam strip**
3. **Foam strip**
4. **Lower radiator hose**
5. **Upper radiator hose**
6. **Hose clamp**
7. **Radiator shroud**
8. **Lock nut**
9. **Radiator**
10. **Hose clamp**
11. **Reservoir hose**
12. **Flange head screw**
13. **Grommet**
14. **Flange nut**
15. **Retaining ring**
16. **Knob**
17. **Bulb seal**
18. **Radiator support assembly**
19. **Retaining ring**
20. **Oil cooler bracket**
21. **Oil cooler**
22. **Carriage screw**
23. **Hydraulic fitting**
24. **Flange head screw**
25. **Clamp**
26. **Flange nut**
27. **Oil cooler bracket (RH shown)**
28. **Flat washer**
29. **Foam plug**
30. **Lock nut**
31. **Foam strip**
32. **Lower radiator support**
33. **Flange head screw**
34. **Bulb seal**
35. **Grommet**
36. **Frame cover**
37. **Flange head screw**
38. **Plate**
39. **Flat washer**
40. **Knob**
41. **Shoulder bolt**
42. **Flat washer**
43. **Coolant reservoir**
44. **Coolant reservoir bracket**
45. **O−ring**
46. **O−ring**
47. **Air cleaner hose**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Open engine hood on the machine.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene−glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

3. Drain radiator into a suitable container using the radiator drain. The radiator drain hose is located near the engine oil filter.

4. Disconnect hoses (upper and lower) from the radiator.

5. Remove air cleaner hose.

6. Disconnect reservoir hose from the vent tube.

7. Detach radiator shroud from the radiator by removing four flange head screws and flat washers. Position shroud away from radiator.

8. Remove screws, flat washers and lock nuts securing the radiator to the support frame. Pull radiator from the machine.

9. Plug any radiator or hose openings to prevent contamination.

Installation

1. Remove any plugs used during the removal procedure.

2. Position radiator to the support frame. Secure radiator to the support frame with lock nuts, flat washers, and screws.

3. Attach radiator shroud to the radiator with flange screws and flat washers. Make sure that clearance between shroud and fan is at least .180” (4.6 mm) at all points.

4. Connect reservoir hose to the vent tube.

5. Connect hoses (upper and lower) to the radiator.

6. Reinstall air cleaner hose.

7. Make sure radiator drain is closed. Fill radiator with coolant (see Operator’s Manual).

8. Close and secure engine hood on the machine.

Engine

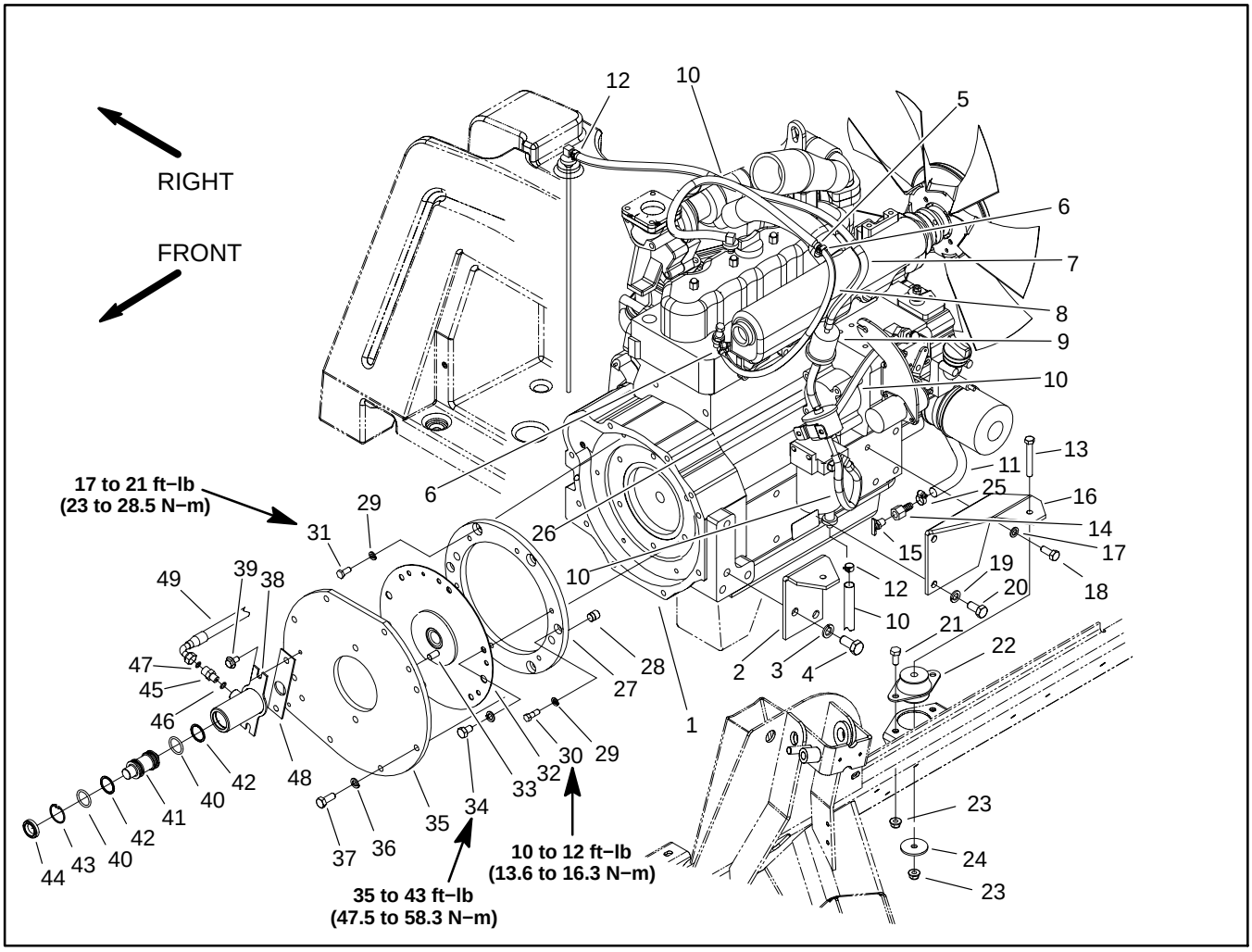

Figure 9

1. Engine
2. Engine mount bracket (RH shown)
3. Lock washer
4. Cap screw
5. Barb fitting
6. Hose clamp
7. Hose
8. Fuel line
9. Fuel filter
10. Fuel line
11. Coolant drain hose
12. Hose clamp
13. Cap screw
14. Barb fitting (female)
15. Coolant drain cock fitting
16. Engine mount bracket (RH shown)
17. Lock washer
18. Cap screw
19. Lock washer
20. Cap screw
21. Cap screw
22. Rubber engine mount
23. Flange head locking nut
24. Rebound washer
25. Hose clamp
26. Fuel line
27. Coupler spacer
28. Dowel
29. Lock washer
30. Shoulder bolt
31. Cap screw
32. Spring center coupling
33. Plate pin
34. Cap screw
35. Pump adapter plate
36. Lock washer
37. Cap screw
38. Traction cylinder assembly
39. Cap screw
40. O−ring
41. Cylinder piston
42. Back−up ring
43. Retaining ring
44. Seal
45. Hydraulic fitting
46. O−ring
47. O−ring
48. Shim plate
49. Hydraulic hose

Engine Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove battery cover and strap. Disconnect negative battery cable first and then positive battery cable. Remove battery from machine.

3. Open engine hood.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene−glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

4. Drain coolant from the radiator into a suitable container (see Radiator Removal). Disconnect coolant hoses from the radiator.

CAUTION

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the exhaust system to cool before working on or near the muffler.

5. Remove exhaust system from engine (see Muffler Removal).

6. Remove air cleaner system from engine (see Air Cleaner Removal).

7. Note location of cable ties used to secure wires. Disconnect wires and/or electrical connections from the following electrical components:

A. The temperature sender and alternator (Fig 10). Note: red wire attached to alternator with washer, nut, and boot does not have to be removed.

B. The engine run solenoid and fuel pump (Fig. 12).

C. The high temperature shutdown switch and glow plug (Fig. 13).

D. Battery, frame, and wire harness ground at the engine block (Fig. 14).

E. The electric starter (Fig. 14) and low oil pressure switch (near electric starter).

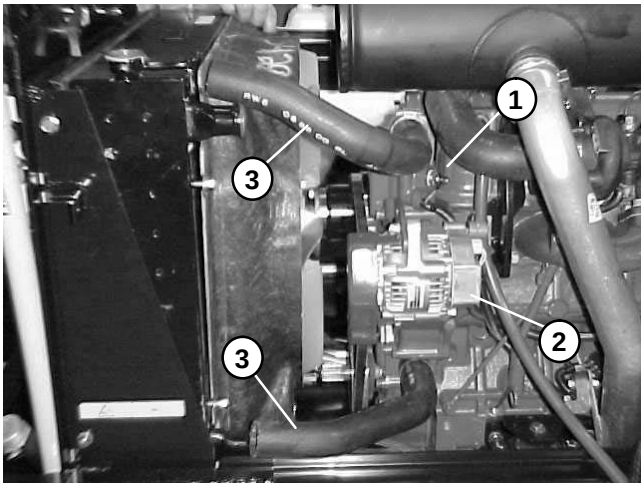

Figure 10

1. **Temperature sender**
2. **Alternator**
3. **Coolant hose**

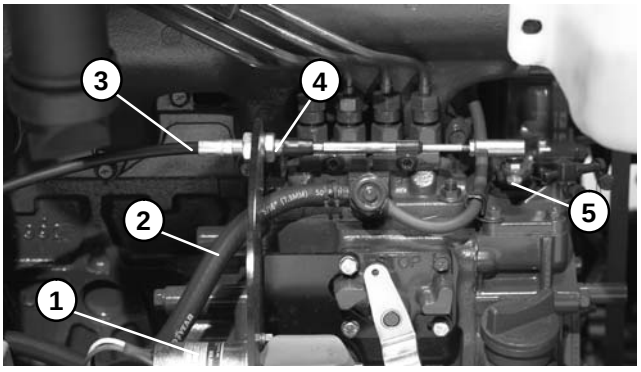

Figure 11

1. **Run solenoid**
2. **Fuel line**
3. **Throttle cable**
4. **Cable jam nut**
5. **Cable washer/lock nut**

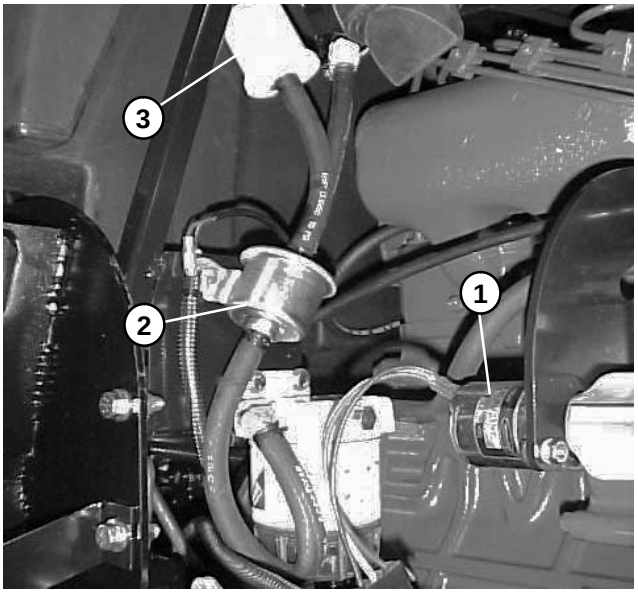

Figure 12

1. **Run solenoid**
2. **Fuel pump**
3. **Fuel filter**

8. Disconnect fuel line from injection pump (Fig. 11).

9. Disconnect throttle cable from the speed control lever by removing the washer and lock nut. Loosen jam nut and take cable from mounting bracket (Fig. 11).

10. Remove coolant reservoir and bracket from fan shroud.

11. Remove four flange head screws and flat washers securing the fan shroud to the radiator.

12. Remove traction cylinder assembly from engine adapter plate. It is not necessary to remove the hydraulic hose from the cylinder. Locate and remove shim plate from between traction cylinder and adapter plate.

13. Disconnect two wires from neutral switch on hydraulic traction pump.

IMPORTANT: Support hydraulic pump assembly to prevent it from falling and being damaged.

14. Remove hydraulic pump assembly from engine (see Pump Assembly in Chapter 4 − Hydraulic Systems).

15. Make sure all cable ties securing the wiring harness, fuel lines, or hydraulic hoses to the engine are removed.

16. Connect hoist or lift to the front and rear lift tabs on engine.

17. Remove flange head locking nuts, rebound washers, and cap screws securing the engine brackets to the engine mounts.

CAUTION

One person should operate lift or hoist while the other person guides the engine out of the machine.

IMPORTANT: Make sure not to damage the engine, fuel and hydraulic lines, electrical harness, or other parts while removing the engine.

18. Slowly remove engine from the machine.

19. If necessary, remove engine mount brackets from the engine using Figure 9 as a guide.

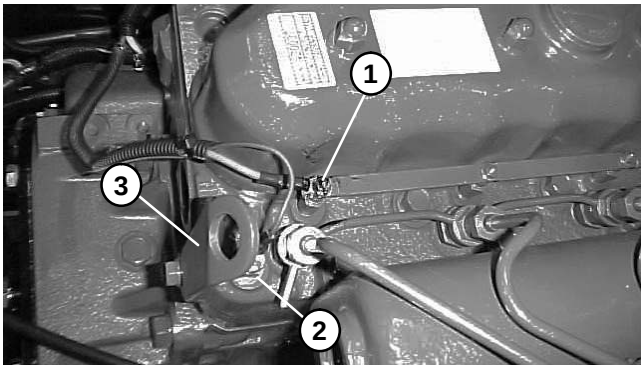

Figure 13

1. **Glow plug wire**
2. **High temp shutdown**
3. **Engine lift tab**

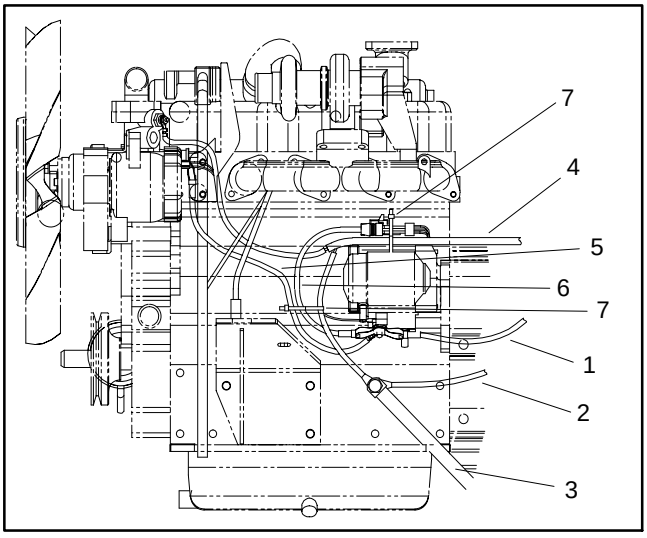

Figure 14

1. **Battery cable (+)**
2. **Battery cable (−)**
3. **Engine to frame ground**
4. **Engine wire harness**
5. **Alternator wire**
6. **Fusible link harness**
7. **Cable tie**

Coupling Disassembly

1. Remove adapter plate, spring coupling, and coupling spacer from engine using Figure 9 as a guide.

Coupling Assembly

1. Position coupling spacer to engine and align mounting holes. Use two shoulder bolts and lockwashers in the positions shown in Figure 15 to secure the spacer to the half threaded holes in engine flywheel. Torque shoulder bolts from 10 to 12 ft−lb (13.6 to 16.3 N−m).

2. Install four cap screws and lockwashers to coupling spacer and flywheel. Torque cap screws from 17 to 21 ft−lb (23 to 28.5 N−m).

3. Place dowels in locating holes of coupling spacer (Fig. 15).

4. Position spring center coupling (coil springs toward engine (Fig. 16)) over dowels. Secure coupling to coupling spacer with cap screws and lockwashers. Torque cap screws from 35 to 43 ft−lb (47.5 to 58.3 N−m).

5. Install plate pins into engine casting. Position pump adaptor plate to engine using plate pins as alignment points. Secure adaptor plate with cap screws and lock washers using a star pattern tightening procedure.

Engine Installation

1. If removed, install engine mount brackets to the engine using Figure 9 as a guide.

2. Connect hoist or lift to the front and rear lift tabs on engine.

3. Position fan shroud around the engine fan.

CAUTION

One person should operate lift or hoist while the other person guides the engine into the machine.

IMPORTANT: Make sure not to damage the engine, fuel and hydraulic lines, electrical harness, or other parts while installing the engine.

4. Slowly lower engine into the machine.

5. Align engine to the rubber engine mounts and secure with cap screws, rebound washers, and flange head locking nuts.

6. Secure fan shroud to the radiator with four cap screws, flat washers, and locknuts. Make sure that clearance between shroud and fan is at least .180" (4.6 mm) at all points.

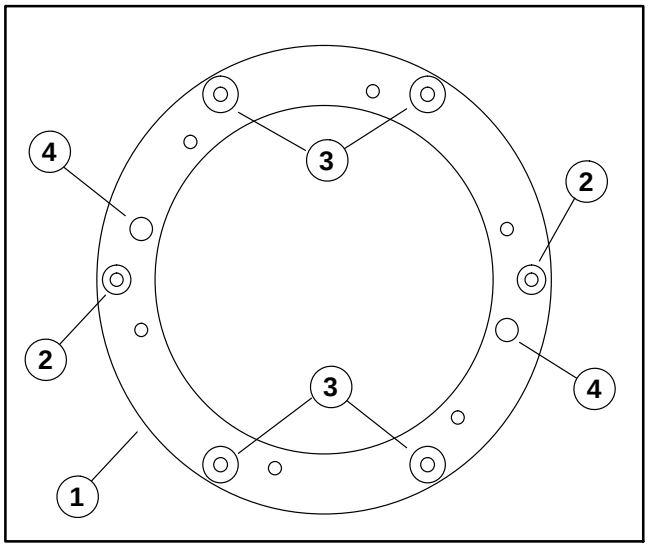

Figure 15

1. **Coupling spacer**
2. **Shoulder bolt position**
3. **Cap screw position**
4. **Dowel position**

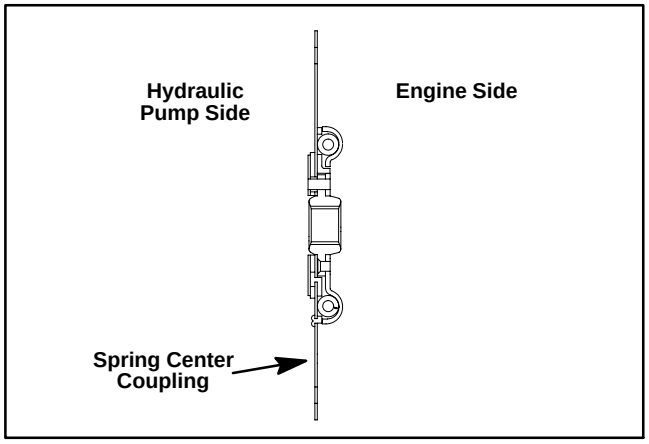

Figure 16

7. Install coolant reservoir bracket and reservoir to fan shroud.

8. Connect throttle cable to the speed control lever with washer and lock nut. Install cable to mounting bracket (Fig. 11). Adjust throttle cable (see Operator's Manual).

9. Connect fuel line to the injection pump (Fig. 11).

10. Install traction cylinder assembly to engine adapter plate.

IMPORTANT: Support hydraulic pump assembly to prevent it from falling and being damaged.

11. Install hydraulic pump assembly to engine (see Pump Assembly in Chapter 4 − Hydraulic Systems).

12. Connect two wires to neutral switch on traction pump.

13. Connect wires and/or electrical connections to the

following electrical components:

A. The temperature sender and alternator (Fig 10).

B. The engine run solenoid and fuel pump (Fig. 12).

C. The high temperature shutdown switch and glow plug (Fig. 13).

D. Battery, frame, and wire harness ground to the engine block (Fig. 14).

E. The starter (Fig. 14) and low oil pressure switch (near starter).

14. Install air cleaner assembly to the engine (see Air Cleaner Installation).

15. Install exhaust system to machine (see Muffler Installation).

16. Connect coolant hoses to the radiator. Make sure radiator drain is shut. Fill radiator and reservoir with coolant (see Operator's Manual).

17. Check position of wires, fuel lines, hydraulic hoses, and cables for proper clearance with rotating, high temperature, and moving components.

18. Position battery to machine. Connect positive battery cable first and then negative battery cable. Secure battery to machine with strap and cover.

19. Check and adjust engine oil as needed (see Operator's Manual).

20. Check and adjust hydraulic oil as needed (see Operator's Manual).

21. Bleed fuel system (see Operator's Manual).

22. Operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System in Chapter 4 − Hydraulic Systems).

TORO

Chapter 4

Hydraulic System

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Specifications

Item	Description
Piston (Traction) Pump System Relief Pressure: Forward System Relief Pressure: Reverse Charge Pressure	Variable displacement piston pump 4000 PSI (274 bar) 5000 PSI (343 bar) 250 PSI (17 bar)
Gear Pump Steering Relief Pressure Lift/Lower Relief Pressure	3 section, positive displacement gear type pump 1350 PSI (93 bar) 1500 PSI (103 bar)
Front Wheel Motors	Fixed displacement piston motors
Rear Axle Motor	Fixed displacement piston motor
Cutting Deck Motors Relief Pressure (front and left side) Relief Pressure (right side)	Gear motor 3000 PSI (207 bar) 2000 PSI (137 bar)
Hydraulic Filters In-line Suction Strainer	10 Micron spin-on cartridge type 100 mesh (in reservoir)
Hydraulic Reservoir	8 gal. (30.3 l)
Hydraulic Oil	See Operator's Manual

General Information

Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions, or mishandling during operation or maintenance. These conditions can cause damage or premature deterioration. Some hoses are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint on the hose. Use two wrenches; hold the hose straight with one and tighten the hose swivel nut onto the fitting with the other.

WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system. Stop engine; lower or support box and/or other attachment(s).

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Hydraulic Fitting Installation

O-Ring Face Seal

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Make sure the O-ring is installed and properly seated in the groove. It is recommended that the O-ring be replaced any time the connection is opened.

3. Lubricate the O-ring with a light coating of oil.

4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.

5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct Flats From Finger Tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	0.75 ± 0.25
6 (3/8 in.)	0.75 ± 0.25
8 (1/2 in.)	0.75 ± 0.25
10 (5/8 in.)	1.00 ± 0.25
12 (3/4 in.)	0.75 ± 0.25
16 (1 in.)	0.75 ± 0.25

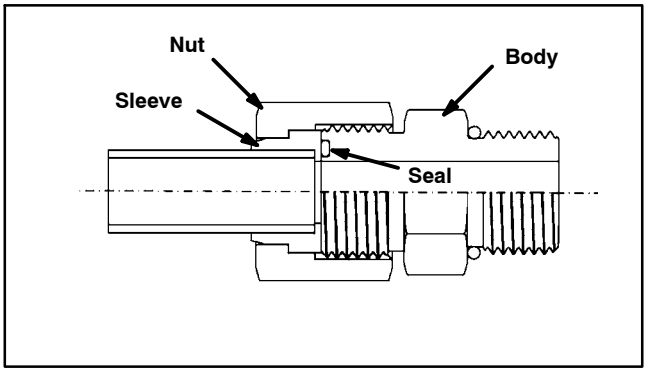


Figure 1

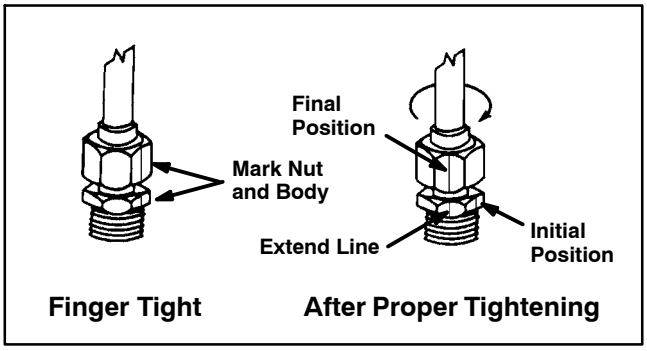


Figure 2

SAE Straight Thread O-Ring Port - Non-adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Always replace the O-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O-ring with a light coating of oil.

4. Install the fitting into the port and tighten it down full length until finger tight.

5. Tighten the fitting to the correct Flats From Finger Tight (F.F.F.T.).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

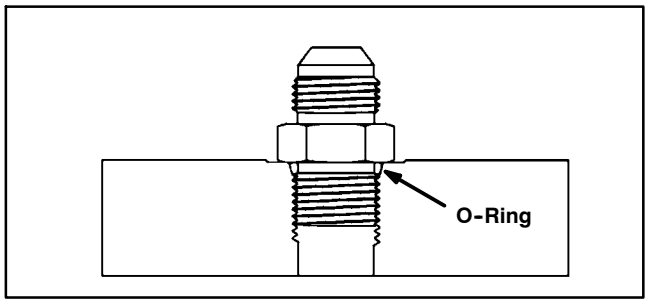


Figure 3

SAE Straight Thread O-Ring Port - Adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Always replace the O-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O-ring with a light coating of oil.

4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

7. Hold the fitting in the desired position with a wrench and turn the jam nut with another wrench to the correct Flats From Finger Tight (F.F.F.T.) (Step 4).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

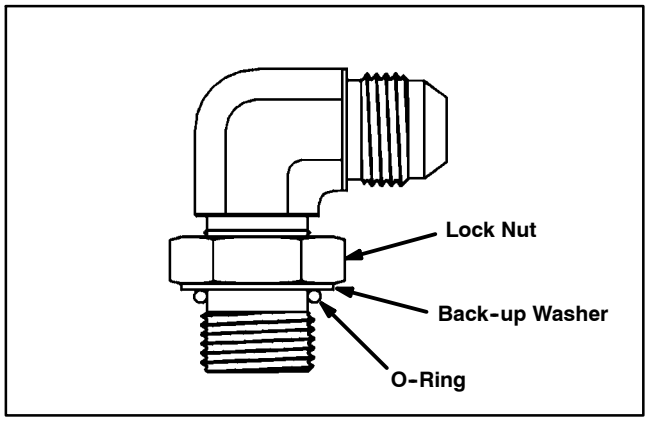


Figure 4

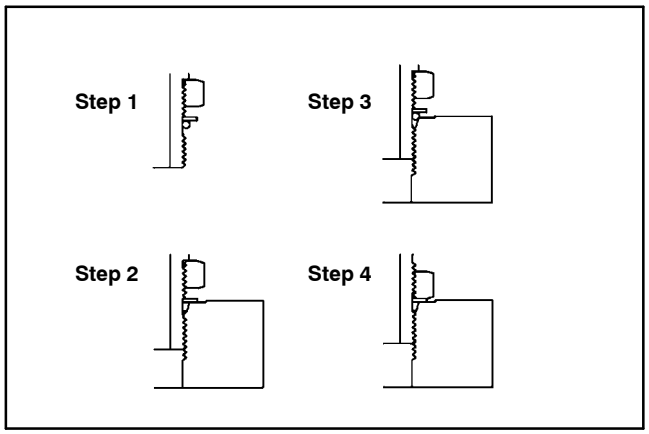


Figure 5

Towing Traction Unit

IMPORTANT: If towing limits are exceeded, severe damage to the piston pump may occur.

If it becomes necessary to tow (or push) the machine, tow (or push) in a **forward direction only** and at a speed **below 3 mph**. The piston (traction) pump is equipped with a by–pass valve that needs to be turned 90º for towing. See Operator's Manual for Towing Procedures.

See Operator's Manual for towing instructions in reverse.

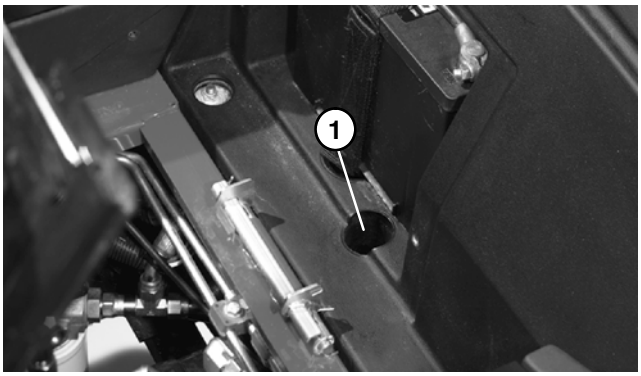


Figure 6

1. **By–pass valve location**

Check Hydraulic Fluid

The Groundsmaster 4000–D hydraulic system is designed to operate on anti–wear hydraulic fluid. The reservoir holds about 8 gallons (30.3 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Operator's Manual for fluid level checking procedure and oil recommendations.

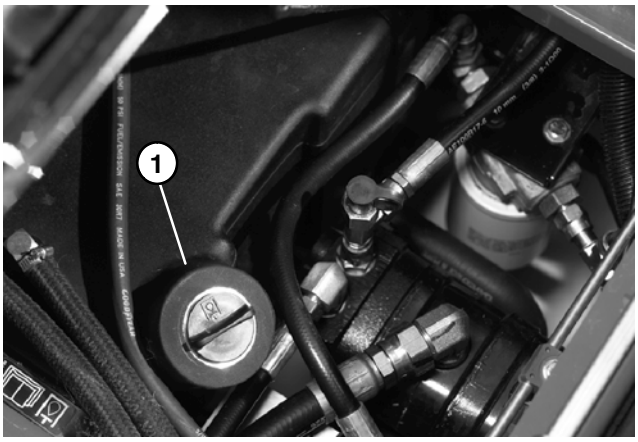
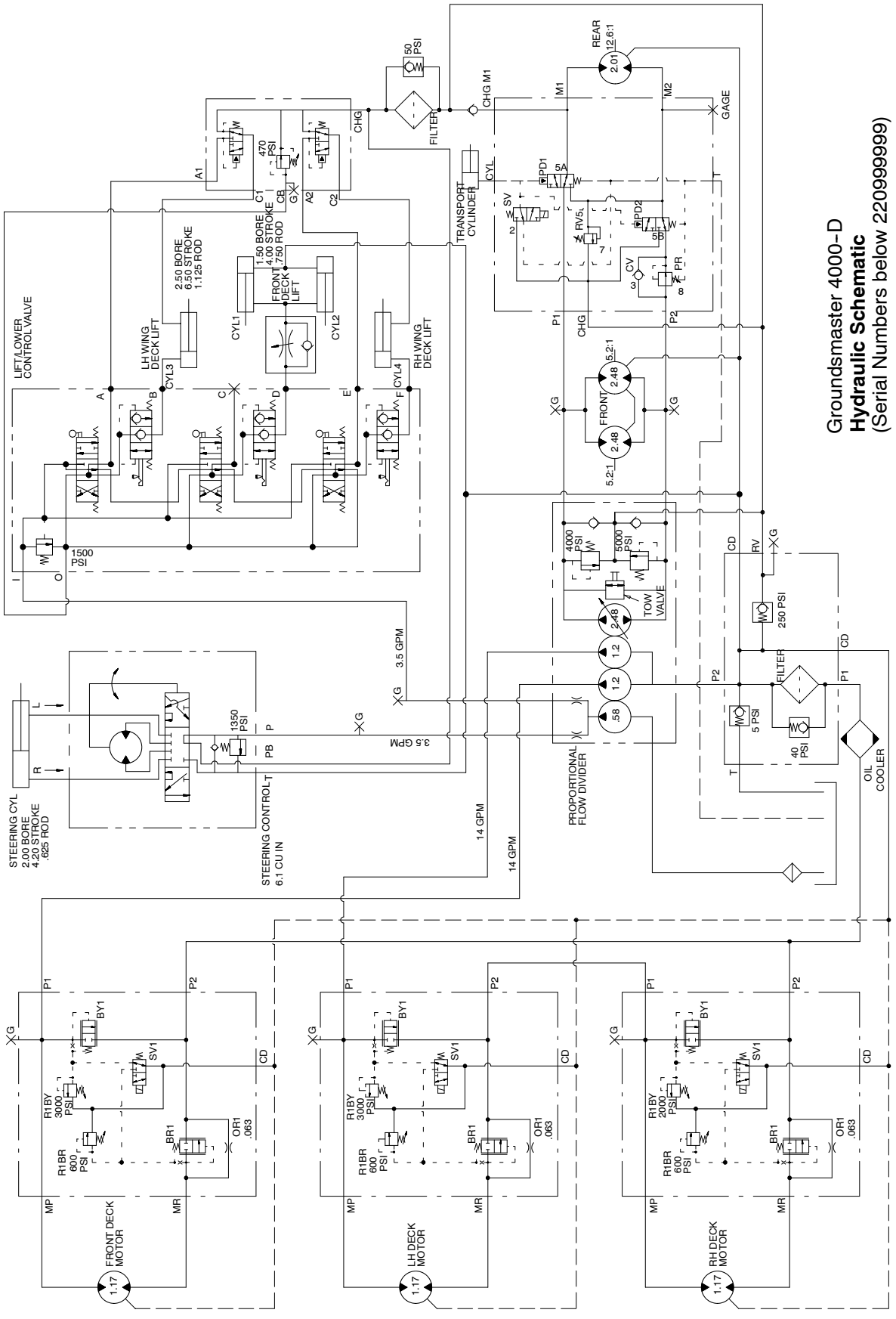
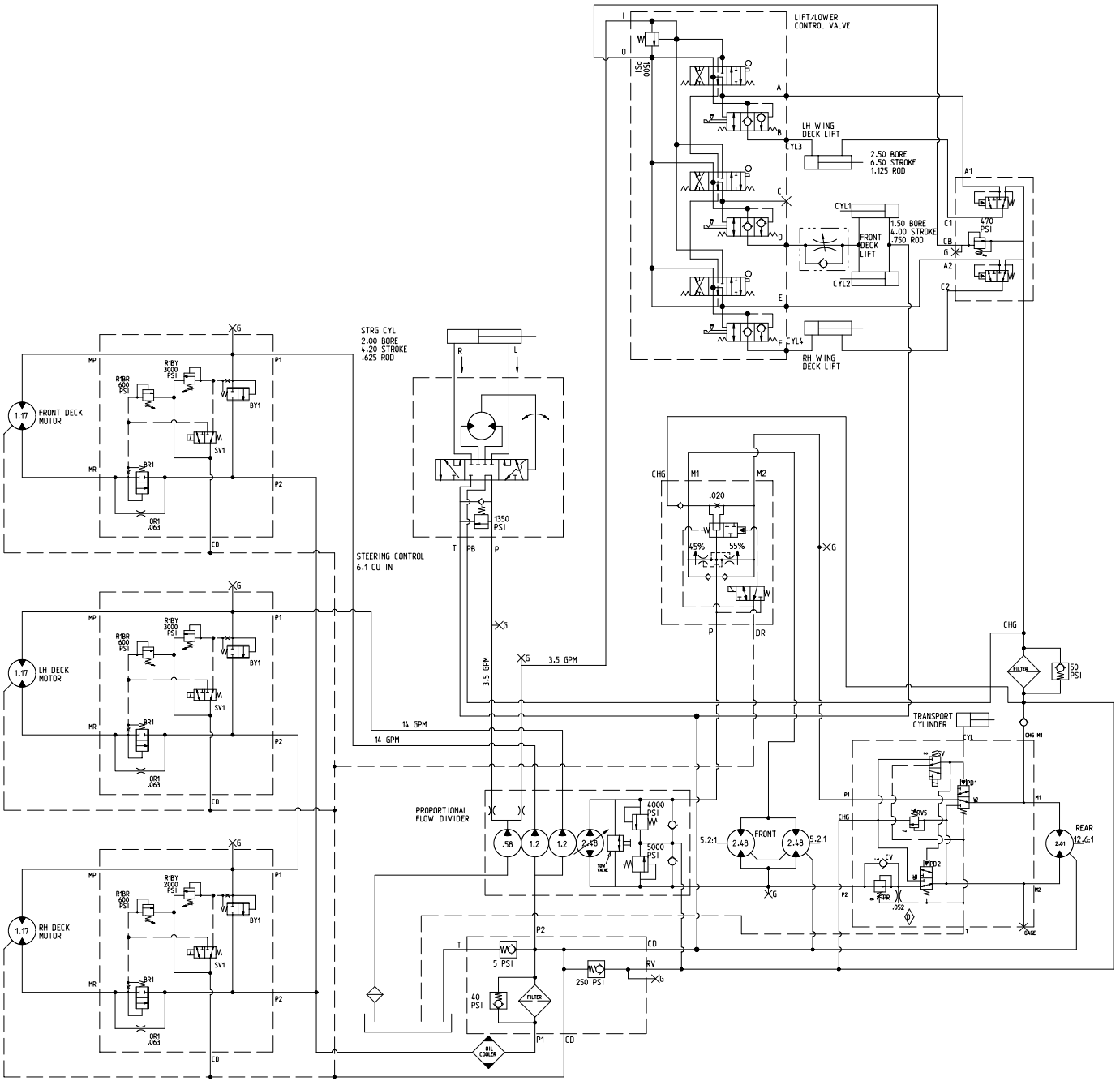


Figure 7

1. **Hydraulic reservoir cap**

Hydraulic Schematics



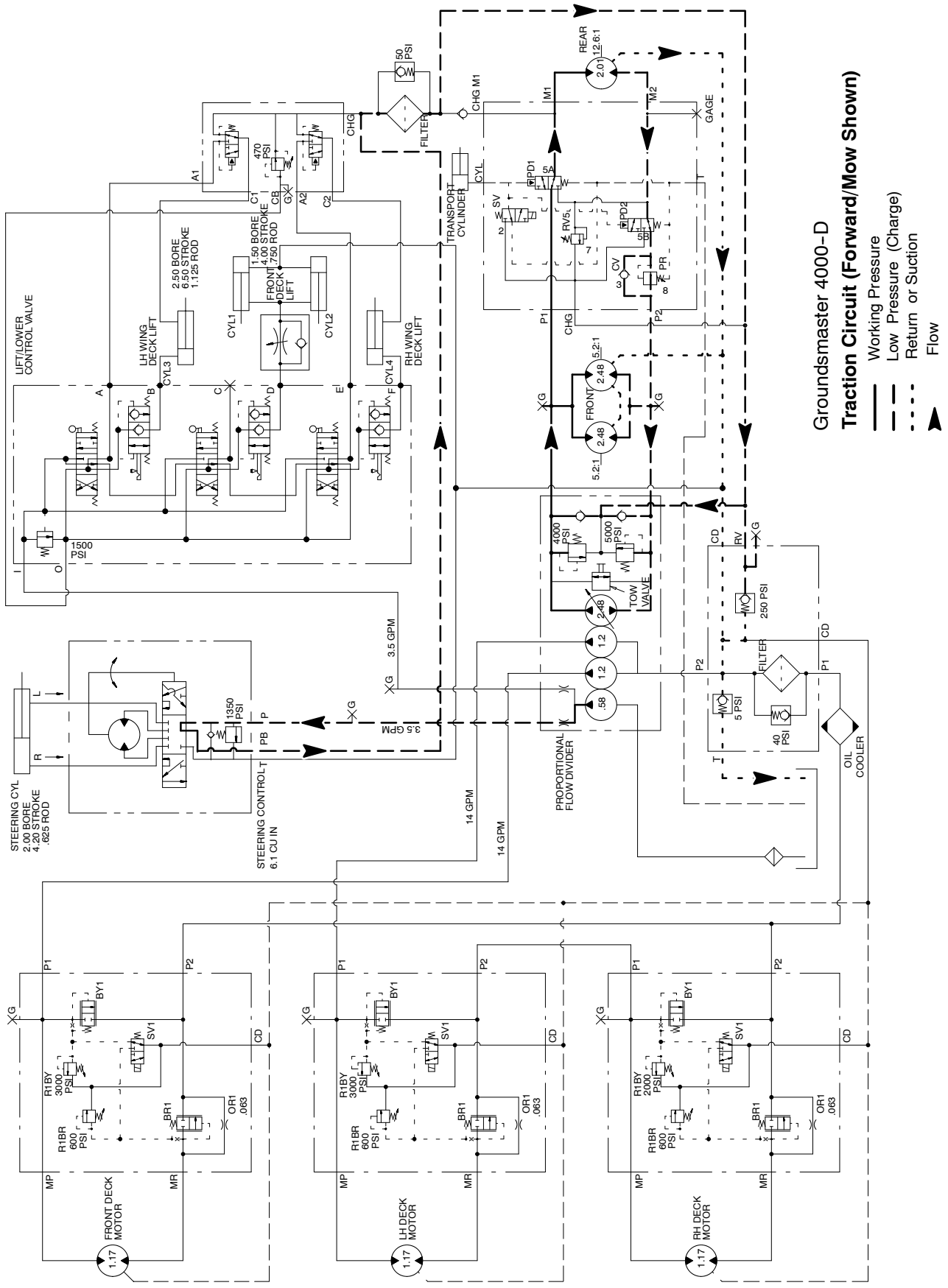


Groundsmaster 4000-D
Hydraulic Schematic
(Serial Numbers above 230000000)

All solenoids are shown as de-energized

Hydraulic System

Hydraulic Flow Diagrams



Traction Circuit

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. Pushing the top of the traction pedal engages a hydraulic servo valve which controls the variable displacement piston pump swash plate to create a flow of oil. This oil is directed to the front wheel and rear axle motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the fixed displacement wheel and axle motors. As the load increases, circuit pressure can increase to relief valve settings: 4000 PSI in forward and 5000 PSI in reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop circuit. The traction circuit provides operation in either four wheel drive (mowing) or two wheel drive (transport).

Traction circuit pressure (forward and reverse) can be measured at test ports on the sides of the machine.

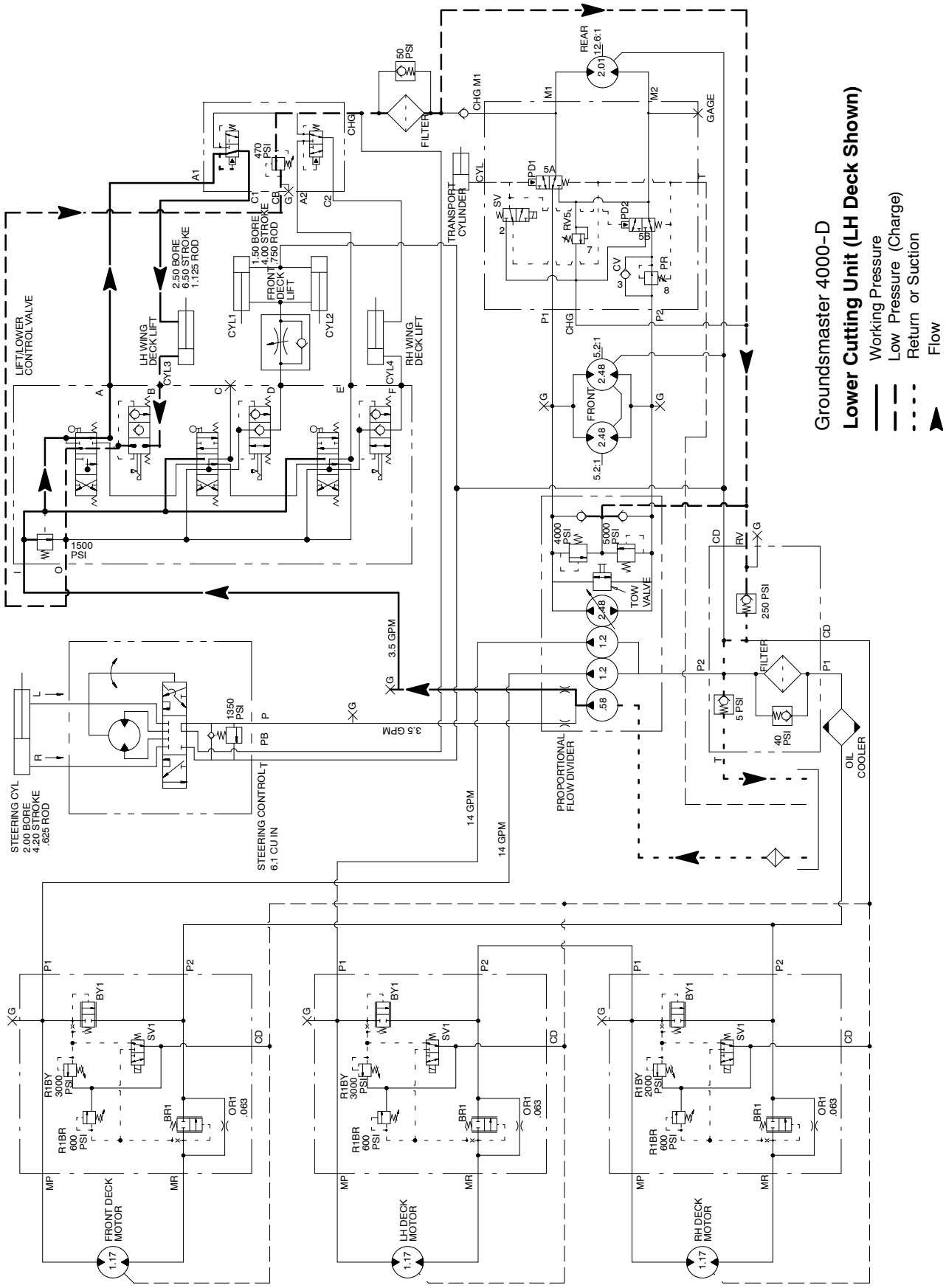
The traction pump uses a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across pump parts into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced.

The gear pump that supplies oil to the steering and lift/lower circuits also provides charge oil for the traction circuit. This gear pump is driven directly off the traction pump. It provides a constant supply of charge oil to the traction circuit to make up for oil that is lost due to internal leakage in the traction pump and motors.

Charge pump flow is directed through the oil filter and to the low pressure side of the closed loop traction circuit. A filter bypass valve allows charge oil flow to the closed loop if the filter becomes plugged. Charge pressure is limited by a relief valve located in the oil filter manifold. Charge pressure can be measured at the charge circuit pressure test port on the oil filter manifold.

Two wheel drive (transport) operation is controlled by a solenoid valve. When in transport, hydraulic flow to the rear axle motor is blocked in both forward and reverse directions. A transport cylinder is included in the traction circuit to reduce control arm movement on the piston pump when operating in two wheel drive (transport). This reduced arm movement limits swash plate rotation to prevent excessive transport speed.

On machines with serial numbers above 230000000, a flow divider is incorporated into the traction circuit. When in four wheel drive, the operator can momentarily engage the traction flow divider when low traction situations could lead to wheel spin. The engaged flow divider splits traction pump flow to the front wheel motors (approximately 45%) and rear axle motor (55%) to reduce the chance that excessive flow goes to a spinning wheel.


Groundsmaster 4000-D
Lower Cutting Unit (LH Deck Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LIFT/LOWER CONTROL VALVE
LH WING DECK LIFT
RH WING DECK LIFT
FRONT DECK LIFT
2.50 BORE 6.50 STROKE 1.125 ROD
1.50 BORE 4.00 STROKE .750 ROD
CYL1
CYL2
CYL3
CYL4
1500 PSI
STEERING CYL 2.00 BORE 4.20 STROKE .625 ROD
STEERING CONTROL T 6.1 CU IN
1350 PSI
3.5 GPM
14 GPM
14 GPM
PROPORTIONAL FLOW DIVIDER
TOW VALVE
4000 PSI
5000 PSI
250 PSI
5 PSI
40 PSI
OIL COOLER
FILTER
50 PSI
470 PSI
CHG
CHG M1
TRANSPORT CYLINDER
REAR 12.6:1
FRONT 5.2:1
GAGE
SV
RV5L
PD1
PD2
CV
PR
R1BY 3000 PSI
R1BY 2000 PSI
R1BR 600 PSI
BR1
OR1 .063
BY1
SV1
FRONT DECK MOTOR
LH DECK MOTOR
RH DECK MOTOR
1.17

Lower Cutting Unit

A three section gear pump is coupled to the piston (traction) pump. The gear pump section farthest from the piston pump supplies hydraulic flow to both the lift/lower control valve and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider. This pump section takes its suction from the hydraulic reservoir.

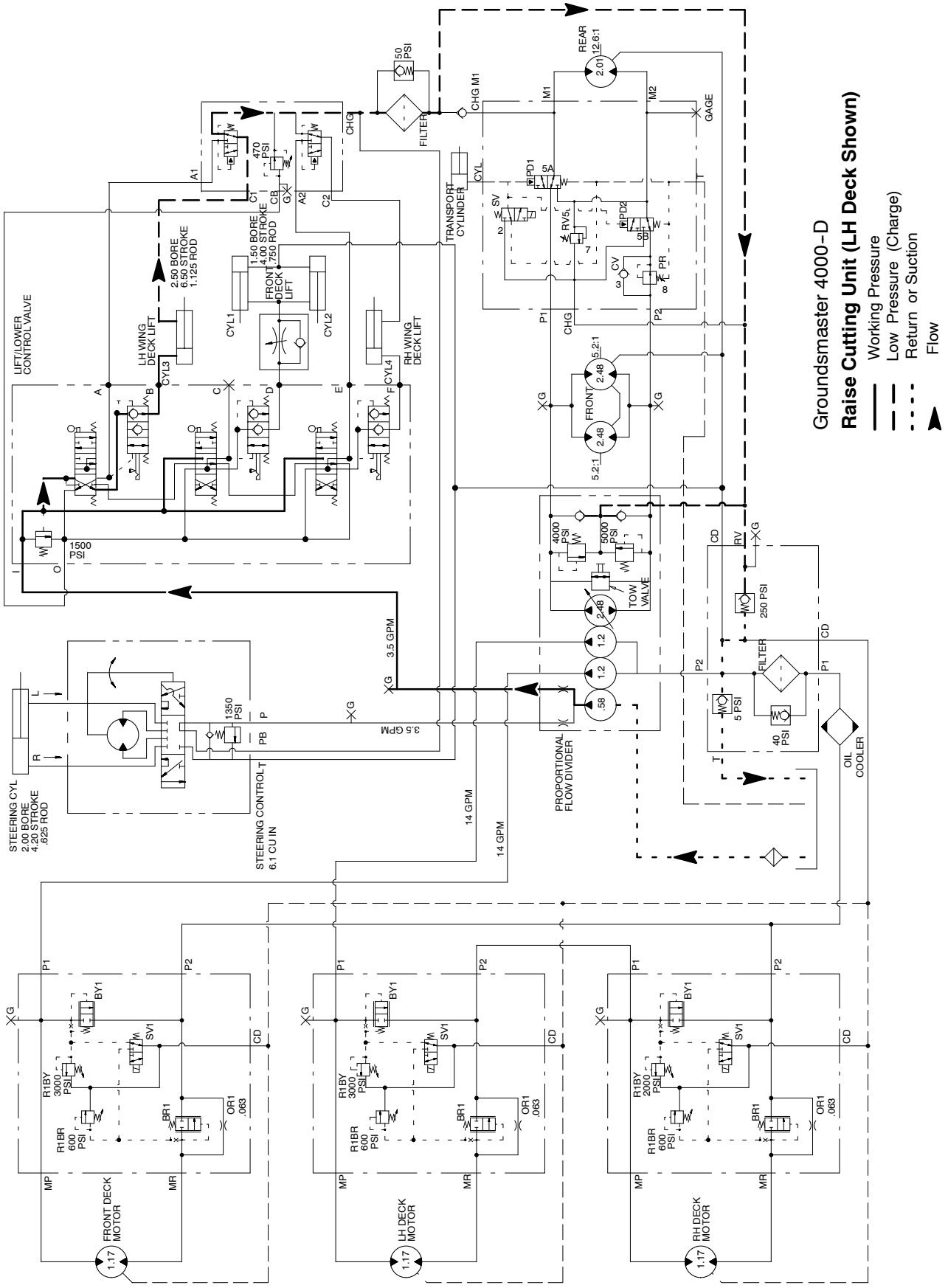
When the cutting units are in a stationary position, flow from the gear pump is by–passed through the lift/lower control valve, counterbalance manifold, oil filter, and traction charge circuit.

To lower a side cutting unit, the appropriate lift lever on the lift/lower control valve is pushed to allow valve shift in the lift/lower control. This valve change causes a valve shift in the counterbalance manifold and oil flow to the rod end of the lift cylinder. Higher hydraulic pressure against the rod end of the cylinder causes the shaft to retract, and lower the cutting unit. Oil from the piston end of the cylinder returns to the traction charge circuit. When the lift lever is released, the lift cylinder is held in position.

To lower the front cutting unit, the center lift lever on the lift/lower control valve is pushed to allow valve shift in the lift/lower control. This valve change allows a passage for oil flow from the rod end of the front deck lift cylinder. The weight of the cutting deck causes the lift cylinder to extend, and lower the cutting unit. Oil from the rod end of the cylinder is allowed to return to the traction charge circuit. When the lift lever is released, the lift cylinder is held in position.

The drop speed of the front cutting units is regulated by an adjustable flow control valve that is located in the hydraulic lines between the lift/lower control valve and the front deck lift cylinders.

An adjustable counterbalance valve maintains back pressure on the side deck lift cylinders. A relief valve located in the lift/lower control valve limits circuit pressure. Excess circuit flow is routed to the oil filter and then to the traction charge circuit.


Groundsmaster 4000-D
Raise Cutting Unit (LH Deck Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LIFT/LOWER CONTROL VALVE
LH WING DECK LIFT
RH WING DECK LIFT
FRONT DECK LIFT
TRANSPORT CYLINDER
STEERING CYL
STEERING CONTROL
PROPORTIONAL FLOW DIVIDER
TOW VALVE
OIL COOLER
FILTER
GAGE
FRONT DECK MOTOR
LH DECK MOTOR
RH DECK MOTOR
1500 PSI
1350 PSI
470 PSI
50 PSI
4000 PSI
5000 PSI
250 PSI
5 PSI
40 PSI
3.5 GPM
14 GPM
REAR 12.6:1
FRONT 5.2:1
2.50 BORE 6.50 STROKE 1.125 ROD
1.50 BORE 4.00 STROKE .750 ROD
2.00 BORE 4.20 STROKE .625 ROD
R1BY 3000 PSI
R1BY 2000 PSI
R1BR 600 PSI
OR1 .063

Raise Cutting Unit

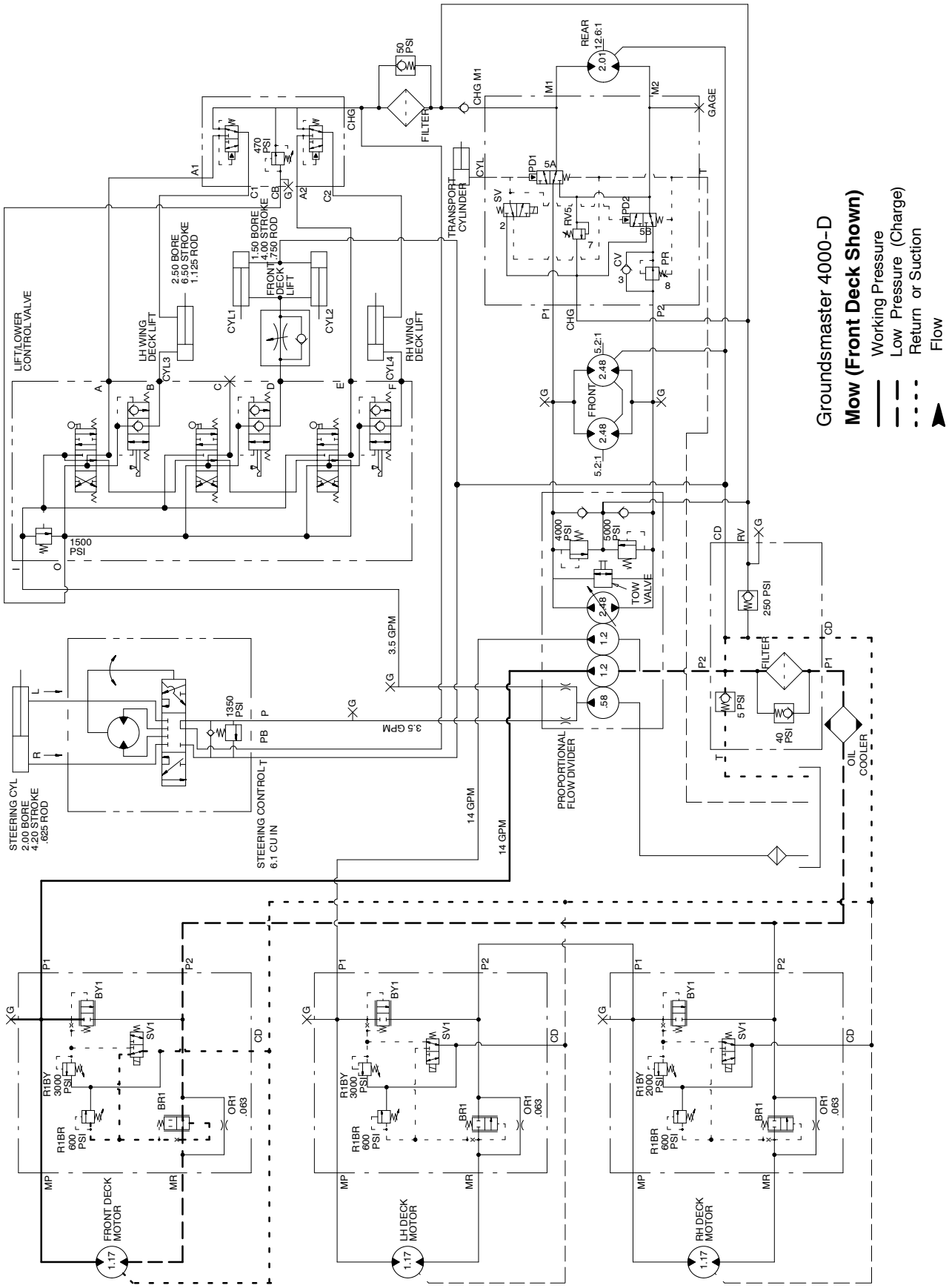
A three section gear pump is coupled to the piston (traction) pump. The gear pump section farthest from the piston pump supplies hydraulic flow to the lift/lower control valve and the steering control valve. Hydraulic flow from this pump section is delivered to the two circuits through a proportional flow divider. The gear pump takes its suction from the hydraulic reservoir.

When the cutting units are in a stationary position, flow from the gear pump is by–passed through the lift/lower control valve, counterbalance manifold, oil filter, and traction charge circuit.

To raise a side cutting unit, the appropriate lift lever on the lift/lower control valve is pulled to allow valve shift in the lift/lower control. This valve change allows hydraulic pressure to the piston end of the lift cylinder and causes the shaft to extend, raising the cutting unit. Oil from the rod end of the cylinder flows to the traction charge circuit. When the lift lever is released, the lift cylinder is held in position.

To raise the front cutting unit, the center lift lever on the lift/lower control valve is pulled to allow valve shift in the lift/lower control. This valve change allows hydraulic pressure to the rod end of the front deck lift cylinders, causing the cylinders to retract. As the cylinders retract, the front deck raises. Oil from the piston end of the cylinder returns to the hydraulic reservoir. When the lift lever is released, the lift cylinder is held in position.

An adjustable counterbalance valve maintains back pressure on the lift cylinders. A relief valve located in the lift/lower control valve limits circuit pressure. Excess circuit flow is routed to the oil filter and then to the traction charge circuit.


Groundsmaster 4000-D
Mow (Front Deck Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LIFT/LOWER CONTROL VALVE
LH WING DECK LIFT
RH WING DECK LIFT
FRONT DECK LIFT
TRANSPORT CYLINDER
STEERING CYL
STEERING CONTROL
PROPORTIONAL FLOW DIVIDER
TOW VALVE
FILTER
OIL COOLER
FRONT DECK MOTOR
LH DECK MOTOR
RH DECK MOTOR
REAR
FRONT
GAGE
14 GPM
3.5 GPM

Mow

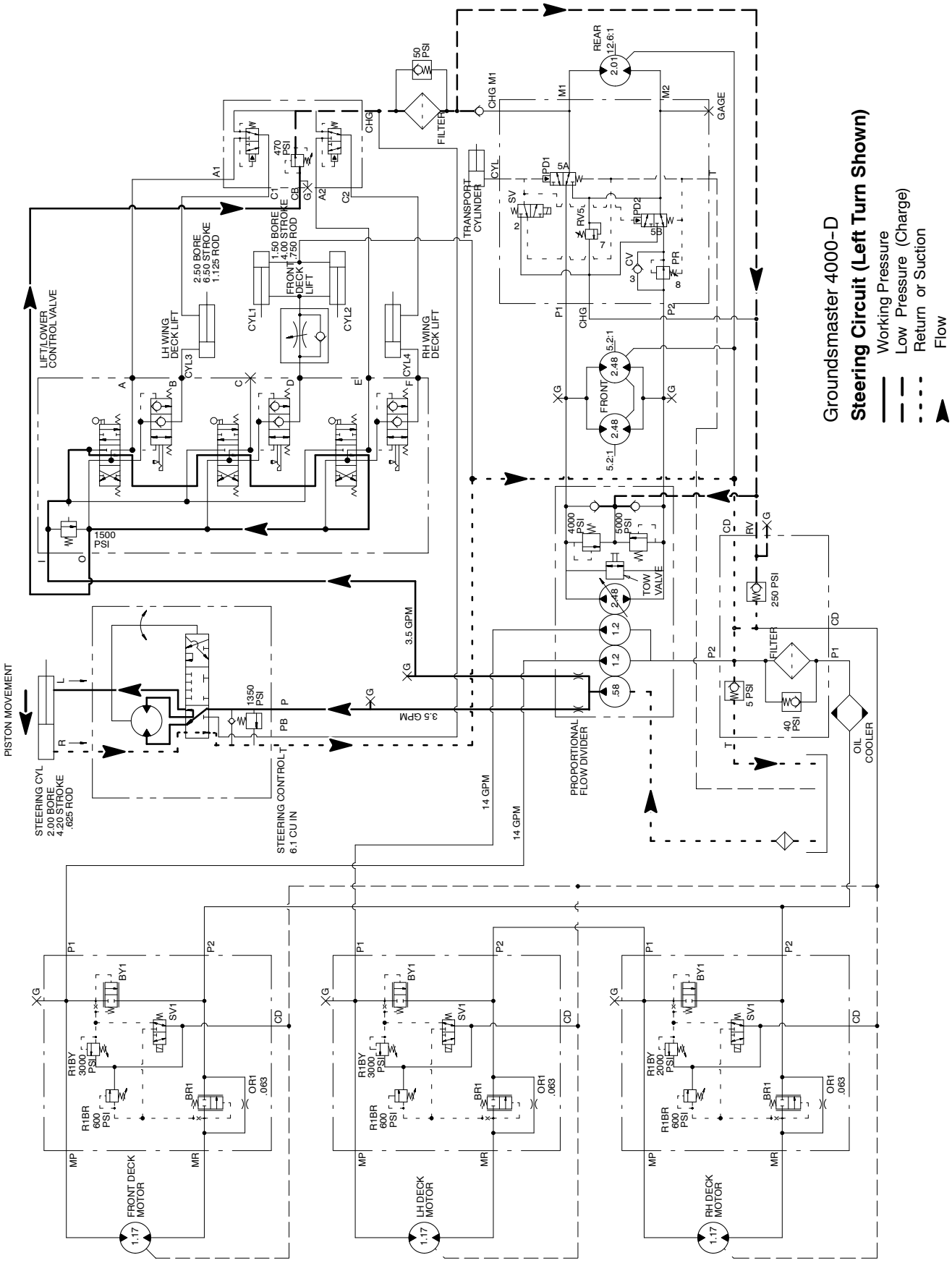
Hydraulic flow for the mow circuit is supplied by two sections of the gear pump. The gear pump section closest to the piston (traction) pump supplies hydraulic flow to the side cutting units, while the next gear pump section supplies the front cutting unit.

Each cutting deck is controlled by a hydraulic manifold equipped with a solenoid control valve (SV1), bypass cartridge (BY1), brake cartridge (BR1) and relief cartridge (R1BR). When the the deck solenoid valve (SV1) is not energized (PTO switch OFF), hydraulic flow bypasses the deck motor through the bypass cartridge (BY1). When the PTO switch is turned ON, the solenoid valve (SV1) energizes, causing a shift of the by–pass cartridge (BY1) and allowing hydraulic flow to the deck motor. Brake cartridge (BR1) and relief cartridge (R1BR) control the stopping rate of the blade when the solenoid control valve is de–energized as the PTO switch is turned OFF.

Return oil from the deck motors is directed to the oil cooler and oil filter. Deck motor case drain leakage returns to the hydraulic reservoir.

Maximum mow circuit pressure is limited at each deck by a relief valve (R1BY) in the hydraulic manifold. The front and left deck relief valves are set at 3000 PSI and the right deck relief valve is set at 2000 PSI.

Circuit pressure can be measured at port (G) of the hydraulic manifold for each cutting deck.


Groundsmaster 4000-D
Steering Circuit (Left Turn Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
REAR
2.01
12.6:1
FRONT
2.48
5.2:1
50 PSI
FILTER
CHG M1
GAGE
TRANSPORT CYLINDER
PD1
PD2
SV
RV5L
CV
PR
CHG
P1
P2
M1
M2
470 PSI
2.50 BORE
6.50 STROKE
1.125 ROD
1.50 BORE
4.00 STROKE
.750 ROD
FRONT DECK LIFT
LH WING DECK LIFT
RH WING DECK LIFT
CYL1
CYL2
CYL3
CYL4
LIFT/LOWER CONTROL VALVE
1500 PSI
4000 PSI
5000 PSI
TOW VALVE
PROPORTIONAL FLOW DIVIDER
RV
250 PSI
5 PSI
40 PSI
OIL COOLER
3.5 GPM
1350 PSI
PISTON MOVEMENT
STEERING CYL
2.00 BORE
4.20 STROKE
.625 ROD
STEERING CONTROL
6.1 CU IN
14 GPM
14 GPM
BY1
SV1
R1BY
3000 PSI
2000 PSI
R1BR
600 PSI
BR1
OR1
.063
MP
MR
FRONT DECK MOTOR
LH DECK MOTOR
RH DECK MOTOR
1.17

Steering Circuit

A three section gear pump is coupled to the piston (traction) pump. The gear pump section farthest from the piston pump supplies hydraulic flow to the steering control valve and the lift/lower control valve. Pump hydraulic flow is delivered to the two circuits through a proportional flow divider. The gear pump takes its suction from the hydraulic reservoir. Steering circuit pressure is limited by a relief valve located in the steering control.

With the steering wheel in the neutral position (rear wheels positioned straight ahead) and the engine running, flow enters the steering control valve at the P port and goes through the steering control spool valve, by–passing the rotary meter (V1) and steering cylinder. Flow leaves the control valve through the PB port to the oil filter and traction charge circuit.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. First, most of the flow through the valve is by–passed out the PB port back to the oil filter and traction charge circuit. Second, the remainder of the flow is drawn through the rotary meter (V1) and out the L port. Pressure contracts the piston for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the T port and to the hydraulic reservoir.

The steering wheel and steering control valve return to the neutral position when turning is completed.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. As in a left turn, most of the flow through the valve is by–passed out the PB port back to the oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port R. Pressure extends the piston for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the T port and to the hydraulic reservoir.

The steering wheel and steering control valve return to the neutral position when turning is completed.

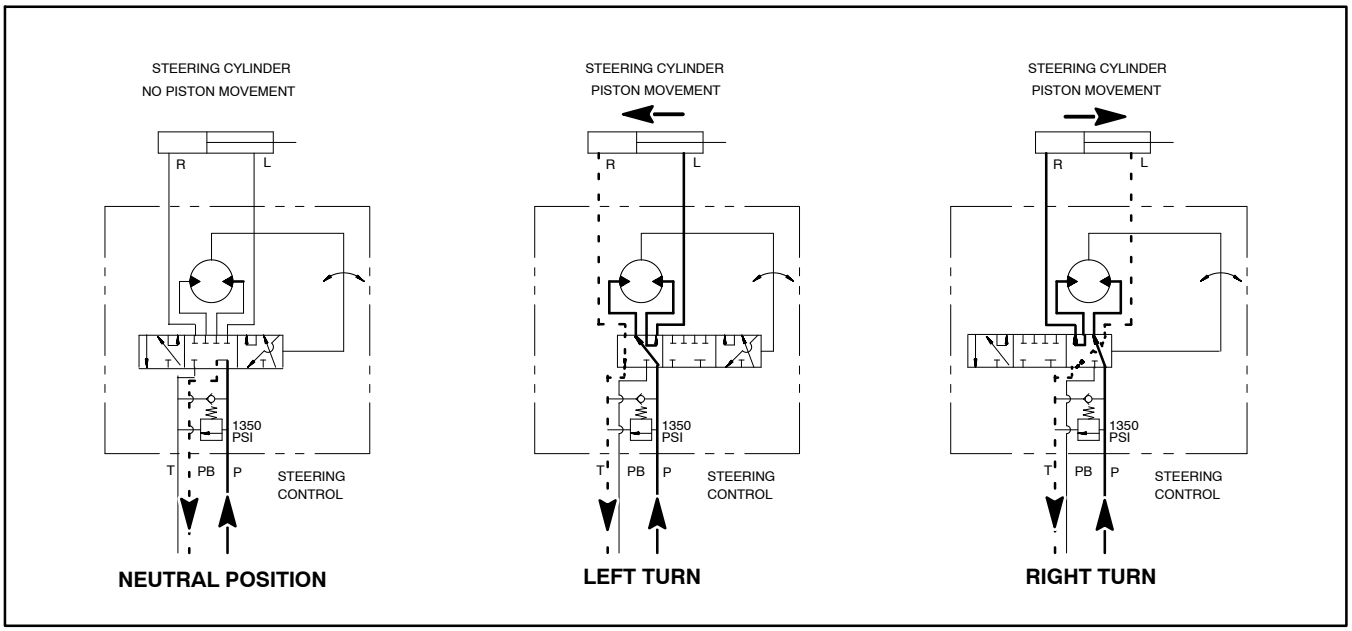


Figure 8

Special Tools

Order these tools from your Toro Distributor.

Hydraulic Pressure Test Kit - TOR47009

Use to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each: 1000 PSI (70 Bar), 5000 PSI (350 Bar) and 10000 PSI (700 Bar) gauges. Use gauges as recommended in Testing section of this chapter.

Figure 9

Hydraulic Tester (Pressure and Flow) - TOR214678

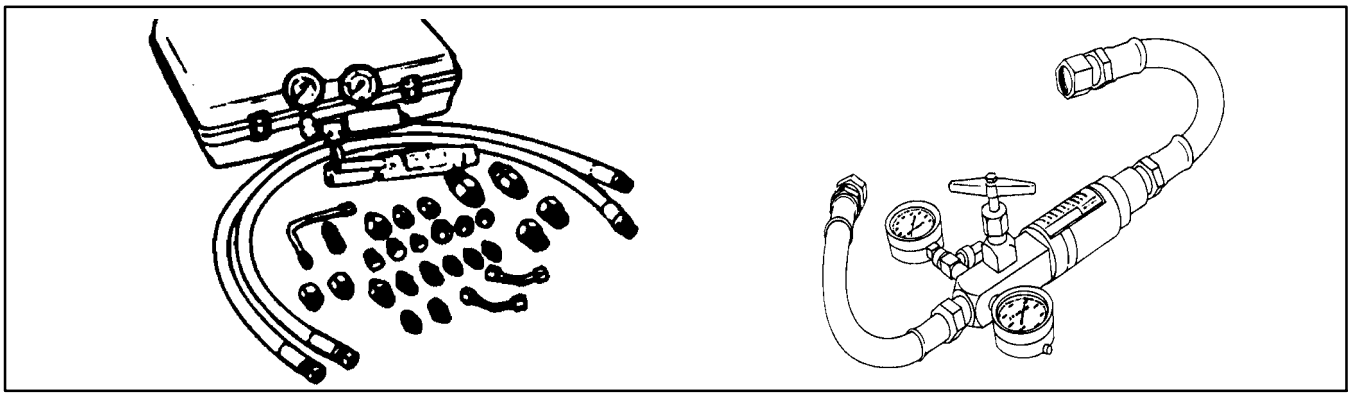


Figure 10

This tester requires O-ring Face Seal (ORFS) adapter fittings for use on this machine.

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

3. LOW PRESSURE GAUGE: Low range gauge to provide accurate reading at low pressure: 0 to 1000 PSI.

   A protector valve cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge which accommodates pressures beyond the capacity of the low pressure gauge: 0 to 5,000 PSI.

5. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.

6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Hydraulic Test Fitting Kit – TOR4079

This kit includes a variety of O–ring Face Seal fittings to enable you to connect test gauges into the system.

The kit includes: tee's, unions, reducers, plugs, caps, and male test fittings.

TORO TEST FITTING KIT (NO. TOR4079)

FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.) Size — Toro No. No. 4 — TOR4079-3 No. 6 — TOR4079-12 No. 8 — TOR4079-4 No. 10 — TOR4079-5
	Plug (2 ea.) Size — Toro No. No. 4 — TOR4079-13 No. 6 — TOR4079-14 No. 8 — TOR4079-15 No. 10 — TOR4079-16
	Cap (2 ea.) Size — Toro No. No. 4 — TOR4079-17 No. 6 — TOR4079-18 No. 8 — TOR4079-19 No. 10 — TOR4079-20

FITTING	TOOL NUMBER
	Union (1 ea.) Size — Toro No. No. 6 to No. 8 — TOR4079-8 No. 10 to No. 8 — TOR4079-2 No. 8 to No. 8 — TOR4079-9
	Reducer (1 ea.) Size — Toro No. No. 10 to No. 8 — TOR4079-7 No. 12 to No. 8 — TOR4079-6
	Test Cap Fitting (2 ea.) Size — Toro No. No. 4 — TOR4079-10 No. 6 — TOR4079-11 No. 8 — TOR4079-21 No. 10 — TOR4079-1
	Test Fitting (2 ea.) Size — Toro No. 7/16–20 ORB — TOR4079-22 1/8" Pipe Thd. — TOR4079-23

Figure 11

Measuring Container – TOR4077

Use this container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

The table in Figure 13 provides gallons per minute (GPM) conversion for measured milliliter or ounce motor case drain leakage.

Figure 12

GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Figure 13

Troubleshooting

The charts that follow contain information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

Refer to the Testing section of this Chapter for precautions and specific test procedures.

Problem	Possible Cause
Hydraulic system operates hot.	Engine RPM is too low. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Brakes are engaged or sticking. Piston pump by–pass valve is open or damaged. Cooling system is not operating properly. Charge pressure is low. Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking in suction line.
Machine operates in one direction only.	Traction control linkage is faulty. System charge check valve and/or system relief valve is defective. Pilot direction valve in 4WD manifold is damaged or sticking.
Traction pedal is sluggish.	Traction control linkage is stuck or binding. Piston pump servo control valve is damaged. Charge pressure is low.
Machine travels too far before stopping when the traction pedal is released.	Traction linkage is out of adjustment. Piston pump servo control valve is damaged. Traction pedal does not return to neutral.
Traction power is lost or unit will not operate in either direction.	Brakes are engaged or sticking. Traction control linkage is damaged or disconnected. Hydraulic reservoir oil level is low. Piston pump by–pass valve is open or damaged. Charge pressure is low. Traction circuit pressure is low. Front wheel motor couplers are damaged.

Problem	Possible Causes
Four wheel drive will not engage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve on 4WD hydraulic manifold is faulty. Cartridge valve in 4WD manifold is damaged or sticking. Rear axle motor is damaged.
Four wheel drive will not disengage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve on 4WD hydraulic manifold is faulty. Cartridge valve in 4WD manifold is damaged or sticking.
No cutting units will operate.	Electrical problem exists (see Chapter 5 – Electrical System). Gear pump or its coupler is damaged.
One cutting unit will not operate.	Electrical problem exists (see Chapter 5 – Electrical System). System pressure to the affected deck is low. Key on affected deck motor is damaged. Solenoid valve in deck manifold is faulty. Cartridge valve in deck manifold is damaged or sticking. Deck motor or gear pump section is damaged.
All cutting decks operate slowly.	Engine RPM is low. Deck motor or gear pump section is damaged.
Cutting deck stops under load.	Relief valve in deck manifold is by–passing. Deck motor has internal leakage (by–passing oil). Cutting deck gear pump section is inefficient.
Cutting units will not raise.	Engine RPM is too low. Hydraulic oil level in reservoir is low. Lift cylinder(s) is (are) damaged. Lift arm pivots are binding. Relief valve in lift/lower control valve is stuck. Pilot valve in lift/lower manifold is damaged or sticking. Gear pump section for lift/lower control valve is inefficient.
Cutting units raise, but will not stay up.	Lift circuit lines or fittings are leaking. Lift cylinder is damaged. Detents in lift/lower control valve are worn.

Problem	Possible Causes
Front cutting unit drops too fast or too slow.	Flow control valve is not adjusted properly.
Cutting units will not lower.	Lift arm pivots are binding. Lift cylinder is damaged. Counterbalance pressure is excessive. Lift/lower control valve is worn or damaged. Pilot valve in lift/lower manifold is damaged or sticking.

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (See the Special Tools section in this Chapter).

Before Performing Hydraulic Tests

IMPORTANT: All obvious areas such as oil supply, filter, binding linkages, loose fasteners, or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem.

Precautions for Hydraulic Testing

CAUTION

Failure to use gauges with recommended pressure (PSI) rating as listed in test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.

CAUTION

All testing should be performed by two (2) people. One person should be in the seat to operate the machine, and the other should read and record test results.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in OFF. Remove key from the ignition switch.

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Do not use hands to search for leaks; use paper or cardboard. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved and all rotating machine parts must be stopped. Stop engine; lower or support attachments.

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of components.

2. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. Use a phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing flow testing.

4. The inlet and the outlet hoses must be properly connected and not reversed (tester with pressure and flow capabilities) to prevent damage to the hydraulic tester or components.

5. When using hydraulic tester with pressure and flow capabilities, open load valve completely in the tester to minimize the possibility of damaging components.

6. Install fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.

7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.

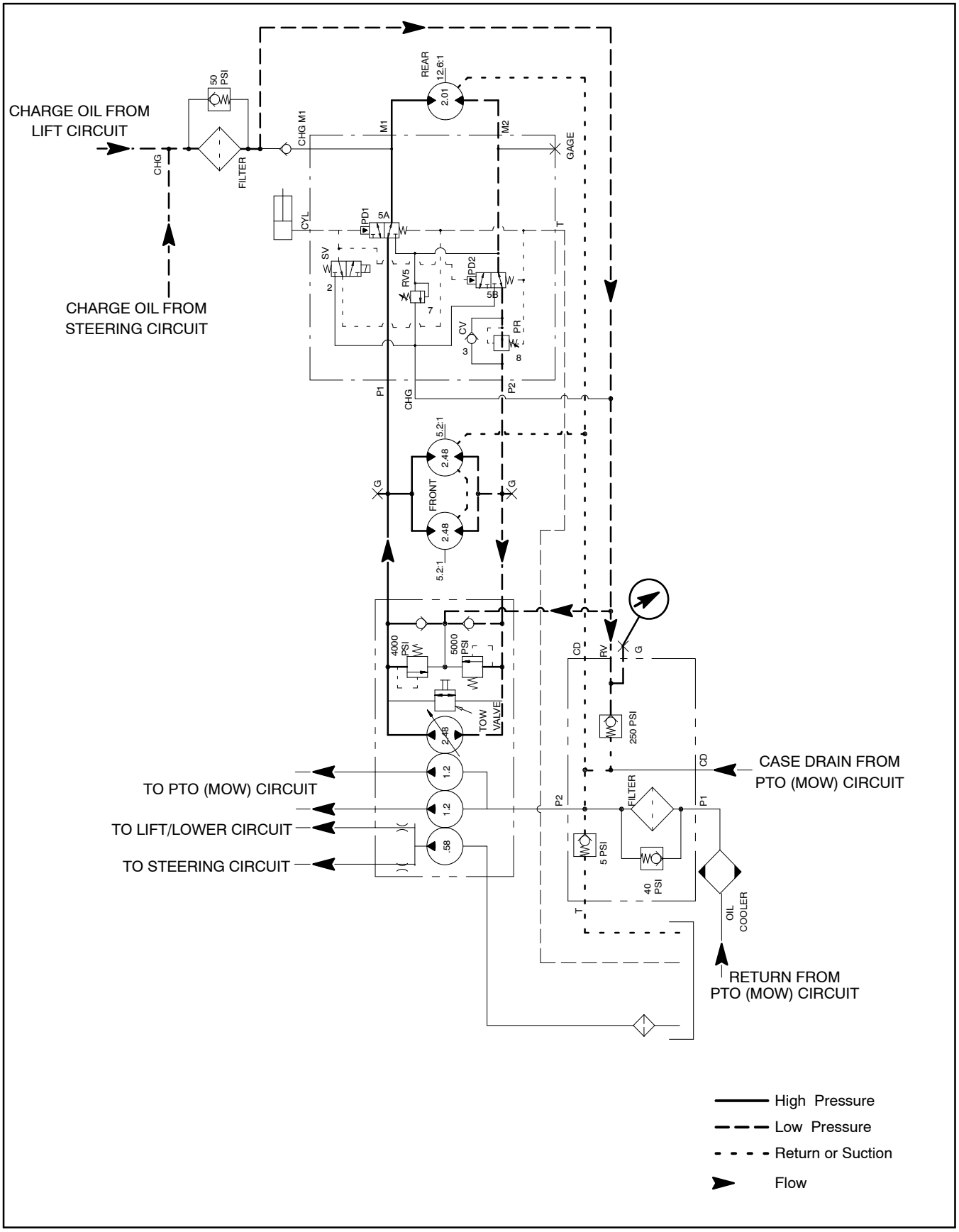
8. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure tank is full.

9. Check control linkages for improper adjustment, binding, or broken parts.

10. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

11. Before returning machine to use, make sure that hydraulic reservoir has correct fluid level.

TEST NO. 1: Traction Circuit Charge Pressure (Using Pressure Gauge)



Procedure for Traction Circuit Charge Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 1000 PSI gauge onto charge pressure test port (Fig. 14) under operator seat.

4. Start the engine and put throttle at full engine speed **(2730 ± 30 RPM)** with no load on the hydraulic system.

GAUGE READING TO BE **200 to 300 PSI**.

5. If there is no pressure, or pressure is low, check for restriction in pump intake line. Also, inspect charge relief valve located in filter manifold (see Hydraulic Manifold Service: Filter Manifold in this chapter). If necessary, check for internal damage or worn parts in gear pump.

6. Also, with the pressure gauge still connected to the charge pressure test port, take a gauge reading while operating the machine in forward and reverse. Start the engine and put throttle at full engine speed **(2730 ± 30 RPM)**. Apply the brakes and push the traction pedal forward, then reverse.

GAUGE READING TO BE **200 to 300 PSI**.

7. If pressure is good under no load, but drops below specification when under traction load, the piston pump and/or traction motor(s) should be suspected of wear and inefficiency. When the pump and/or traction motor(s) are worn or damaged, the charge pump is not able to keep up with internal leakage in traction circuit components.

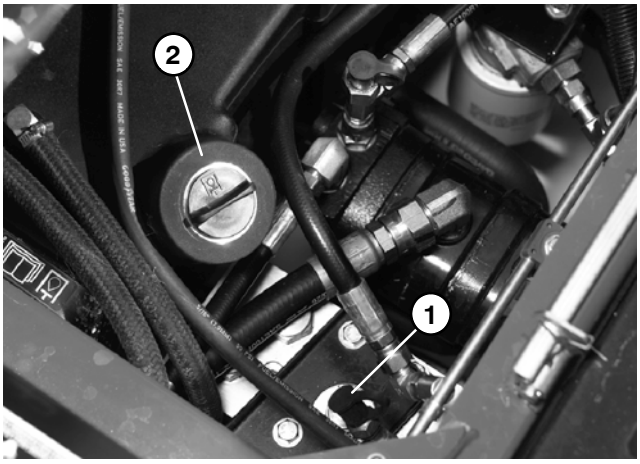
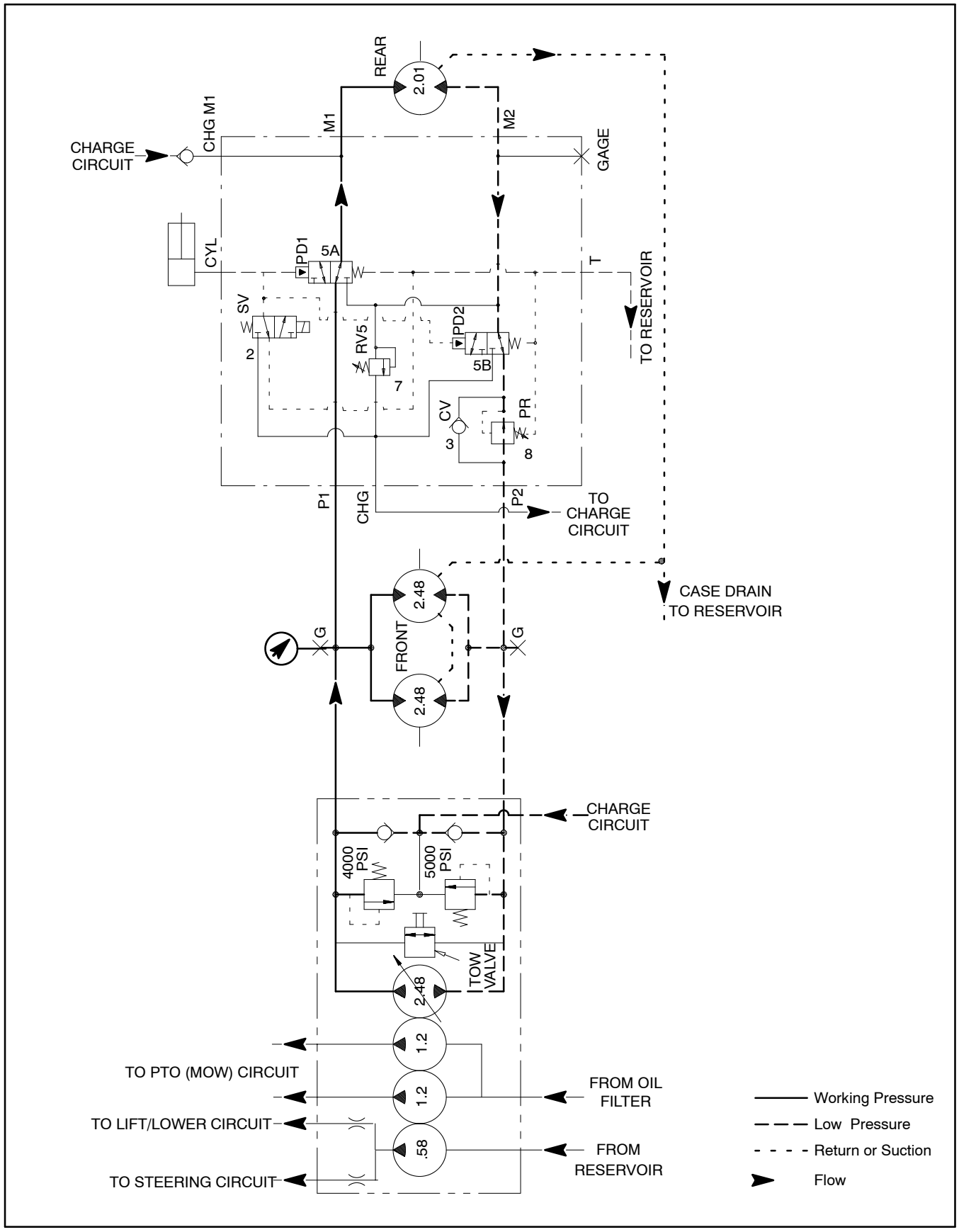


Figure 14

1. **Charge pressure port**
2. **Hydraulic reservoir cap**

TEST NO. 2: Traction Circuit Relief Pressure (Forward Shown) (Using Pressure Gauge)



Procedure for Traction Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

CAUTION

Move machine to an open area, away from people and obstructions.

2. Drive machine to an open area, lower cutting units, turn the engine off and engage the parking brake.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 10,000 psi gauge to traction circuit test port for function to be checked (Fig. 16).

4. Start the engine and move throttle to full speed **(2730 ± 30 RPM)**. Release parking brake.

5. Sit on seat, apply brakes fully, and slowly depress the traction pedal in the appropriate direction. While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE:
Forward: **4000 PSI**
Reverse: **5000 PSI**

6. If traction pressure is too low, inspect traction pump relief valves (Fig. 17). Clean or replace valves as necessary. These cartridge type valves are factory set, and are not adjustable. If relief valves are in good condition, traction pump or wheel motors should be suspected of wear and inefficiency.

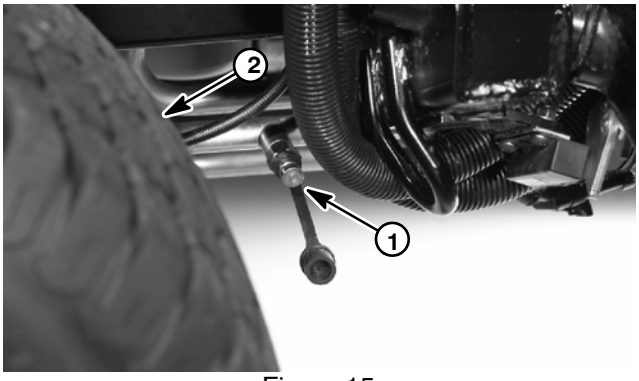


Figure 15

1. **Forward traction port**
2. **Left front wheel**

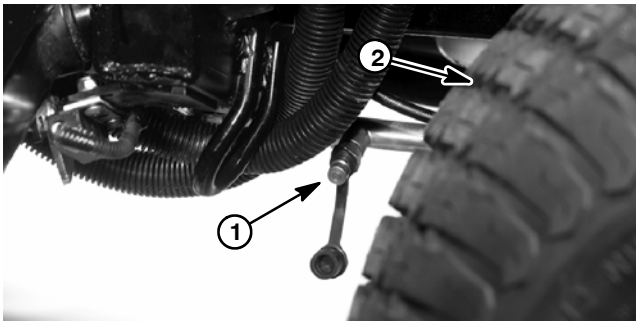


Figure 16

1. **Reverse traction port**
2. **Right front wheel**

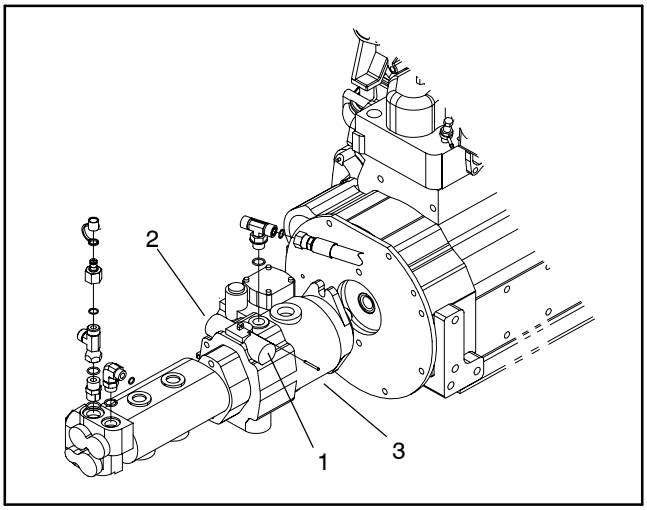
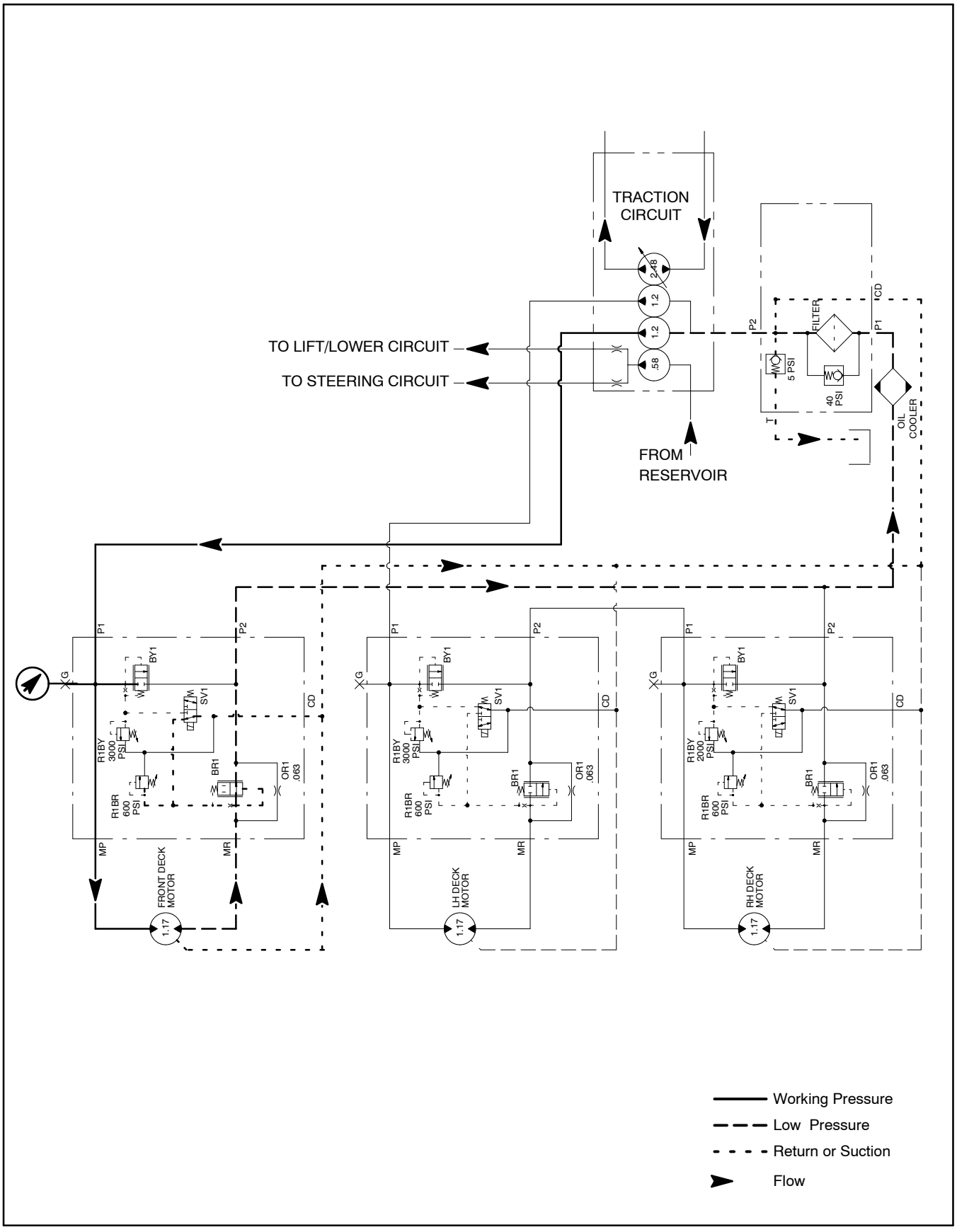


Figure 17

1. **Forward relief valve**
2. **Reverse relief valve**
3. **Traction pump**

TEST NO. 3: Cutting Deck Circuit Pressure (Front Deck Shown) (Using Pressure Gauge)



Procedure for Cutting Deck Circuit Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Install test gauge with hydraulic hose attached to manifold test port for the deck to be tested (Fig. 18, 19, and 20).

CAUTION

Keep away from decks during test to prevent personal injury from the cutting blades.

4. Start engine and move throttle to full speed **(2730 ± 30 RPM)**. Engage the cutting units.

5. Watch pressure gauge carefully while mowing with the machine.

6. Cutting deck circuit pressure should be from **1000 to 3000 PSI** and will vary depending on mowing conditions.

7. Disengage cutting units. Shut off engine.

8. Disconnect test gauge with hose from manifold test port.

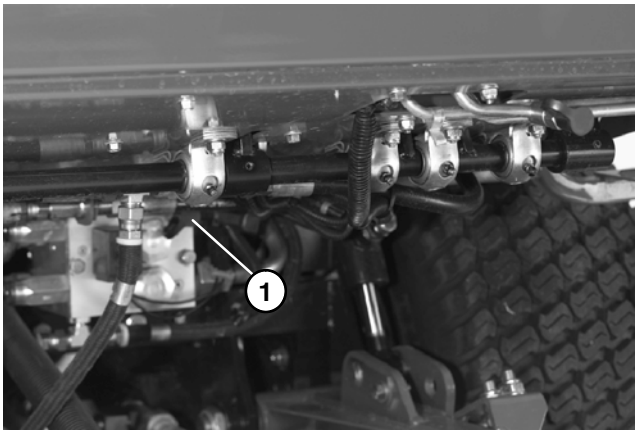


Figure 18

1. **Front deck circuit pressure test port**

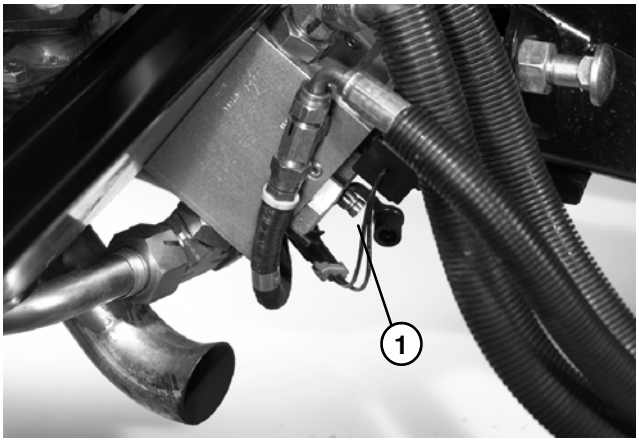


Figure 19

1. **Right deck circuit pressure test port**

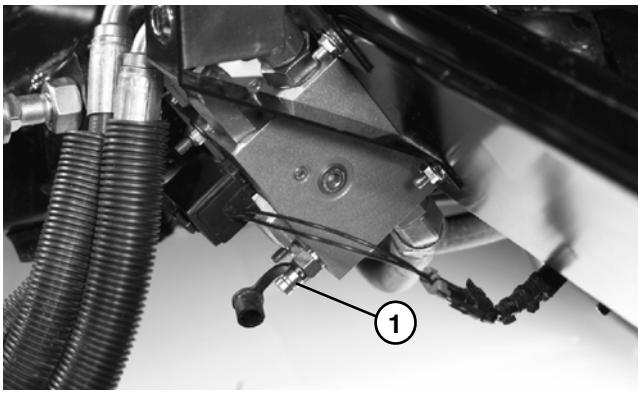
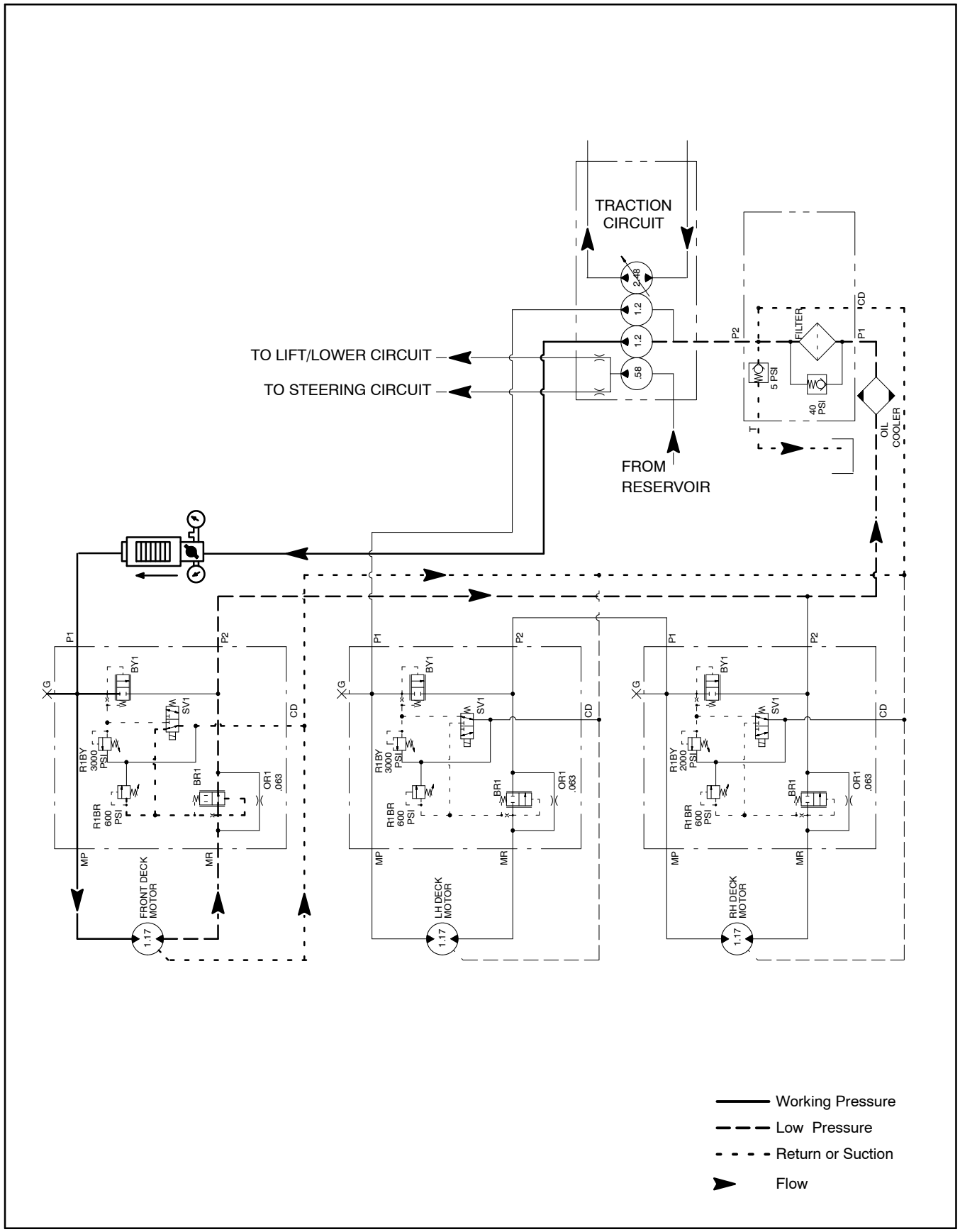


Figure 20

1. **Left deck circuit pressure test port**

TEST NO. 4: Cutting Deck Gear Pump Flow (Front Deck Shown) (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Cutting Deck Gear Pump Flow Test

NOTE: Over a period of time, the gears and wear plates in the pump can wear. A worn pump will by pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause the cutting unit motors to stall under heavy cutting conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Locate deck manifold for gear pump section to be tested. Disconnect hydraulic hose at deck manifold port (P1) (Fig. 21).

4. Install tester in series with the the disconnected hose and hydraulic manifold port (P1).

5. Make sure the flow control valve on the tester is fully open.

6. Start engine and move throttle to full speed **(2730 ± 30 RPM)**. **Do not engage the cutting units**.

IMPORTANT: Do not fully restrict oil flow through tester. In this test, the flow tester is positioned before the relief valve. Pump damage can occur if the oil flow is fully restricted.

7. Watch pressure gauge carefully while slowly closing the flow control valve until **2000 PSI** is obtained. Verify with a phototac that the **engine speed** is **2730 ± 30 RPM**.

8. Flow indication should be approximately **14 GPM**.

9. Shut off engine.

10. Disconnect flow tester from hydraulic hose and manifold port. Reconnect hose to the manifold.

11. If flow was less than **14 GPM** or a pressure of **2000 PSI** cannot be obtained, check for restriction in the pump intake line. If line is not restricted, remove gear pump and repair or replace as necessary.

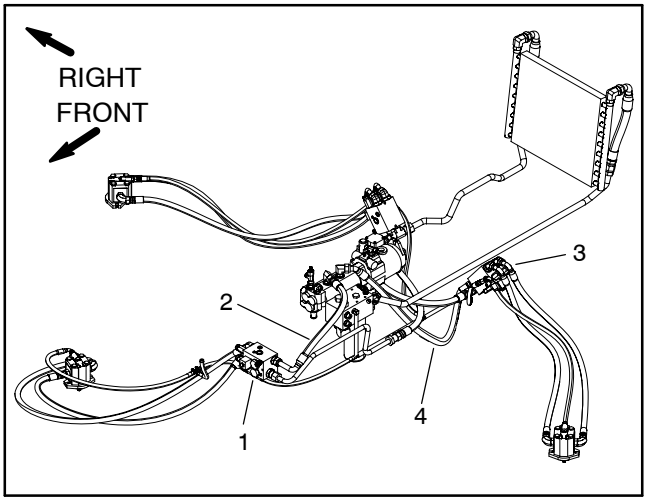
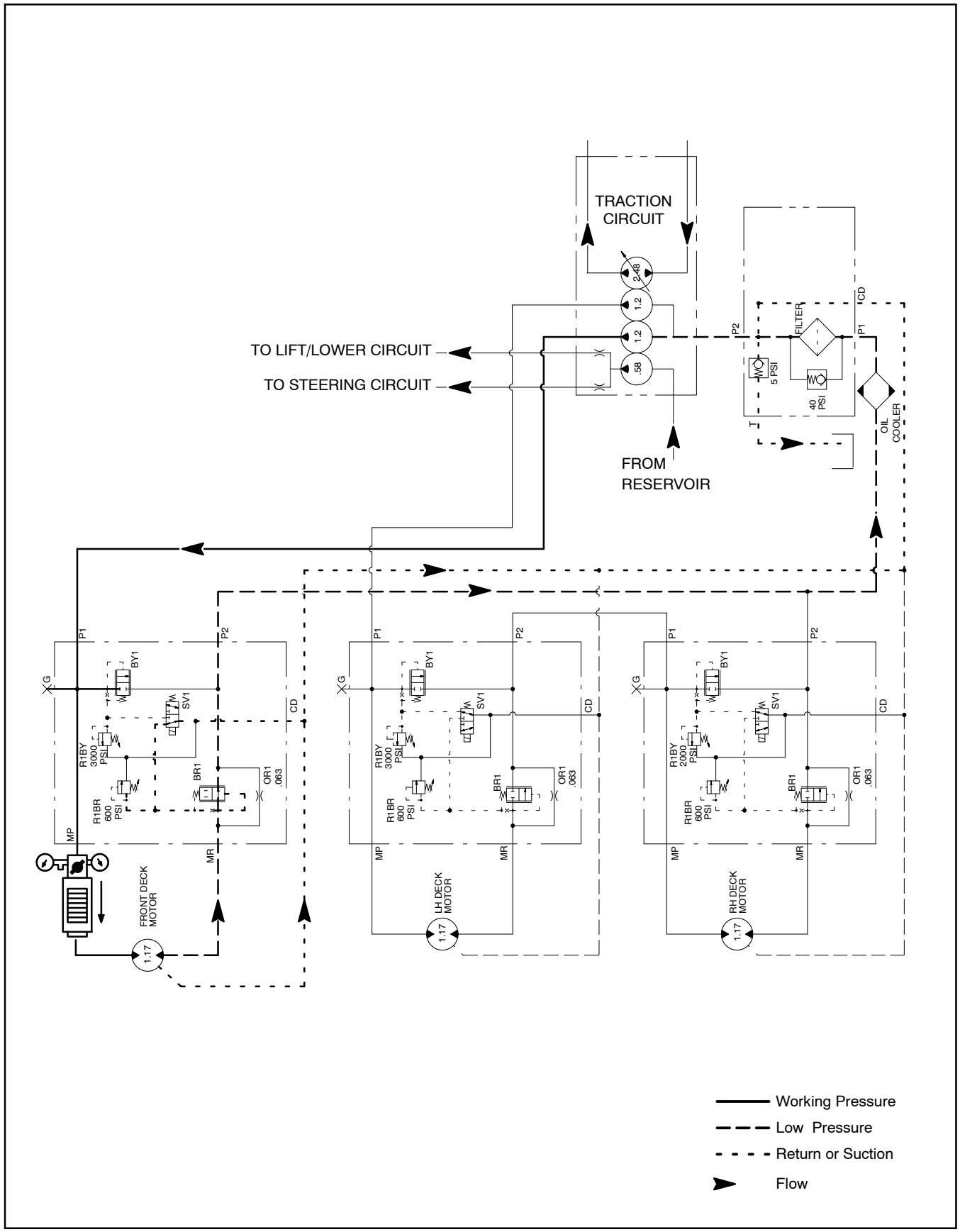


Figure 21

1. **Front deck manifold**
2. **Hyd. hose to front P1**
3. **Side deck manifold**
4. **Hyd. hose to side P1**

TEST NO. 5: Cutting Deck Manifold Relief Pressure (Front Deck Shown) (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Cutting Deck Manifold Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Locate deck manifold to be tested (Fig. 22). Disconnect hydraulic hose at deck manifold port (MP).

NOTE: An alternative to using manifold port (MP) would be to disconnect the inlet hydraulic hose to the deck motor.

4. Install tester in series with the the disconnected hose and hydraulic manifold port (MP) (or motor inlet if hose was disconnected at deck motor).

5. Make sure the flow control valve on the tester is fully open.

6. Install tester in series with the hose and hydraulic fitting. Make sure the flow control valve on tester is fully open.

CAUTION

Keep away from decks during test to prevent personal injury from the cutting blades.

7. Start engine and move throttle to full speed **(2730 ± 30 RPM)**. Engage the cutting units.

8. Watch pressure gauge carefully while slowly closing the flow control valve to fully closed.

9. As the relief valve lifts, system pressure should be approximately:

3000 PSI for the front and left decks
2000 PSI for the right deck

10. Disengage cutting units. Shut off engine. If specification is **not** met, adjust or clean relief valve in deck manifold port (R1BY). Adjust relief valve as follows:

NOTE: Do not remove valve from the hydraulic manifold for adjustment.

A. Remove cap on relief valve with an allen wrench.

B. To **increase** pressure setting, turn the adjustment screw on the valve in a clockwise direction. A 1/8 turn on the screw will make a measurable change in relief pressure.

C. To **decrease** pressure setting, turn the adjustment screw on the valve in a counterclockwise direction. A 1/8 turn on the screw will make a measurable change in relief pressure.

D. Reinstall and tighten cap to secure adjustment. Recheck relief pressure and readjust as needed.

11. Disconnect tester from manifold and hose. Reconnect hydraulic hose that was disconnected for test procedure.

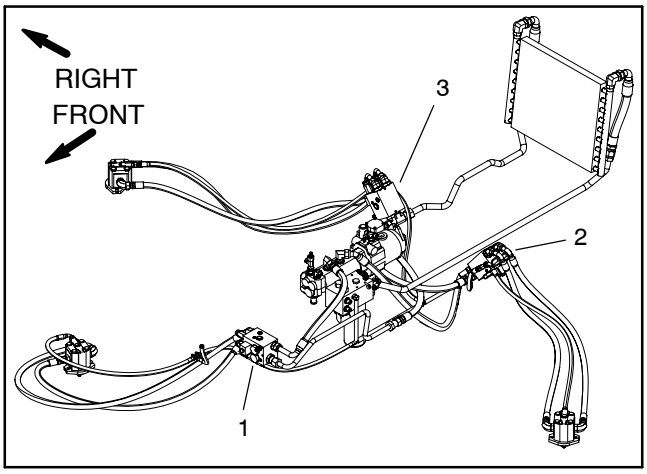


Figure 22

1. **Front deck manifold**
2. **LH deck manifold**
3. **RH deck manifold**

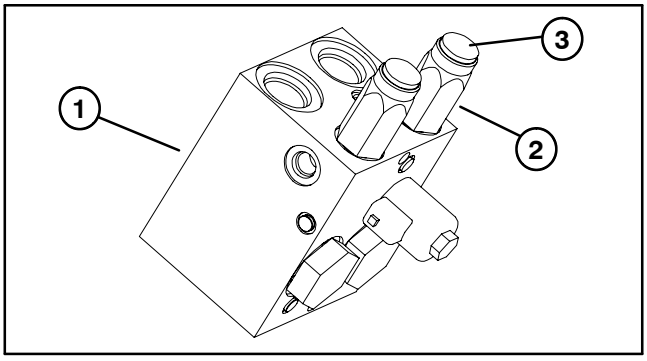
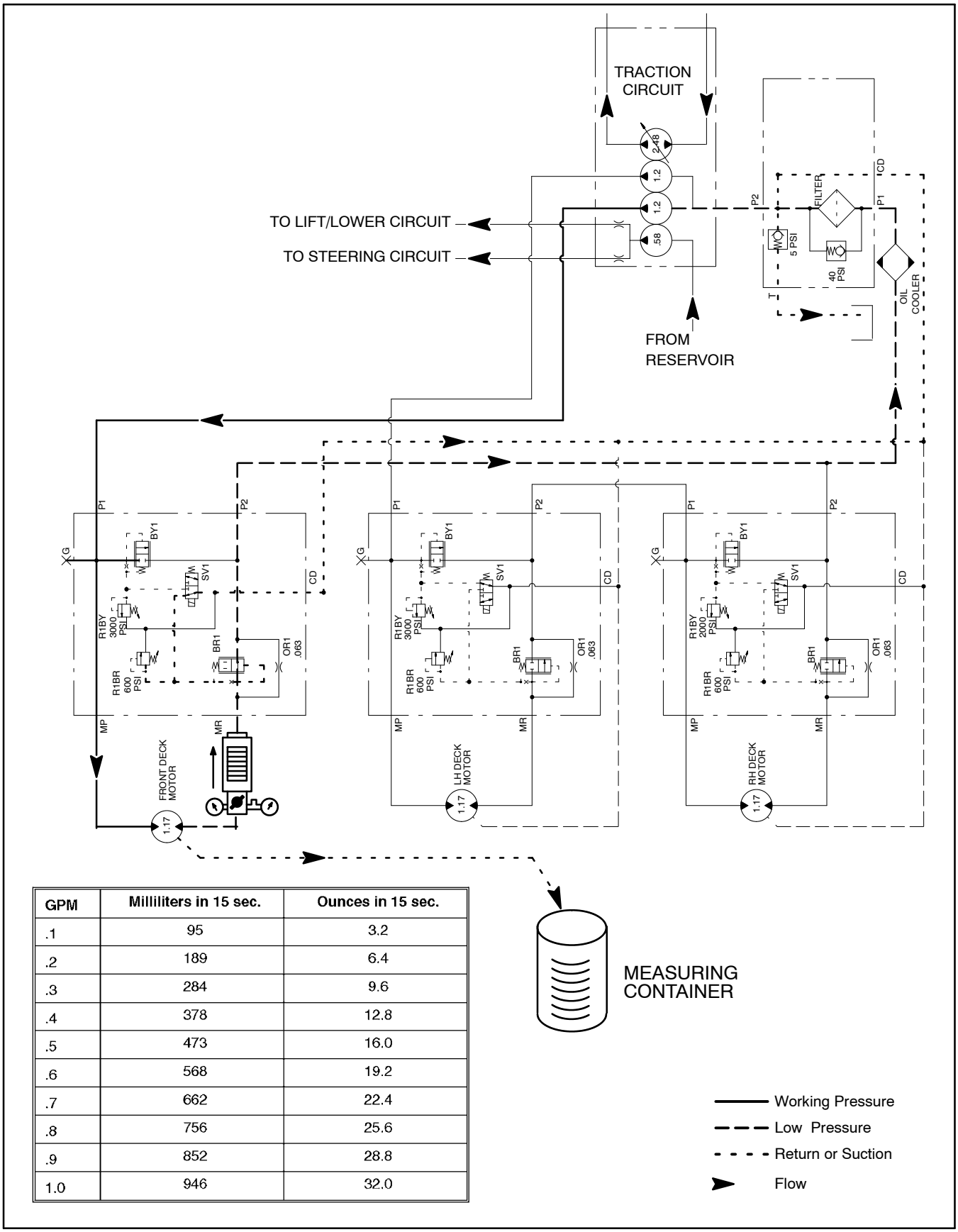


Figure 23

1. **Deck manifold**
2. **Relief valve**
3. **Relief valve cap**

TEST NO. 6: Cutting Deck Motor Case Drain Leakage (Using Tester with Pressure Gauges and Flow Meter)



GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Procedure for Cutting Deck Motor Case Drain Leakage Test

NOTE: Over a period of time, a deck motor can wear internally. A worn motor may by−pass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect quality of cut.

NOTE: One method to find a failing or malfunctioning deck motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings, and may cause a different appearance on the turf.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

NOTE: The side deck motors are connected in series. To isolate a faulty motor, both motors in the circuit may have to be tested by starting with the left side motor first.

3. Disconnect hose from return of the motor to be tested (Fig. 24). Install flow tester in series with the motor and disconnected return hose. Make sure the flow control valve on tester is fully open. (Fig. 25).

4. Disconnect the motor case drain hose (small diameter hose) where it connects to hydraulic manifold tee−fitting (not at the motor). Put a steel cap on the fitting at the tee−fitting; leave the case drain hose open (Fig. 25).

CAUTION

Cutting unit blades will rotate when lowered with PTO switch in ON position. Keep away from cutting units during test to prevent personal injury from rotating blades. Do not stand in front of the machine.

5. Sit on seat and start the engine. Move throttle to full speed **(2730 ± 30 RPM)**. Move PTO switch to ON.

6. While watching pressure gauge, slowly close flow control valve on tester until a pressure of **1200 PSI** is obtained.

NOTE: Use a graduated container, special tool TOR4077, to measure case drain leakage (Fig. 25).

7. Have another person measure flow from the case drain line for **15 seconds**, then move the PTO switch to OFF and stop the engine.

   TEST RESULTS: Flow less than **0.7 GPM** (less than **22.4 ounces (662 ml)** of hydraulic fluid in 15 seconds).

8. Disconnect tester from motor and hose. Reconnect hose to the deck motor. Remove cap from tee−fitting and reconnect case drain hose.

9. If flow is more than **0.7 GPM**, the motor is worn or damaged and should be repaired or replaced.

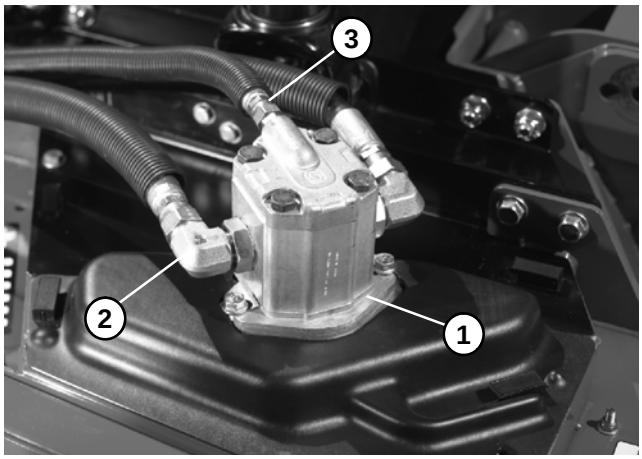


Figure 24

1. **Deck motor (RH shown)**
2. **Return hose**
3. **Case drain hose**

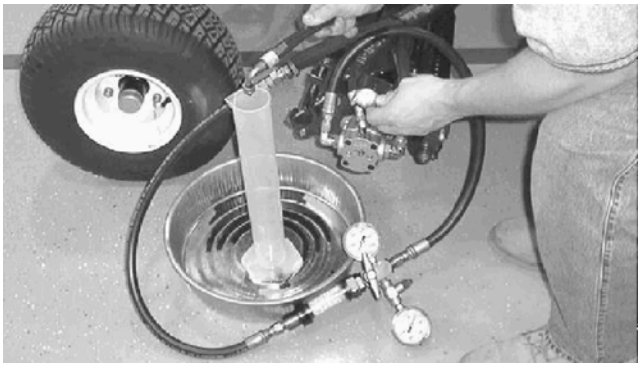
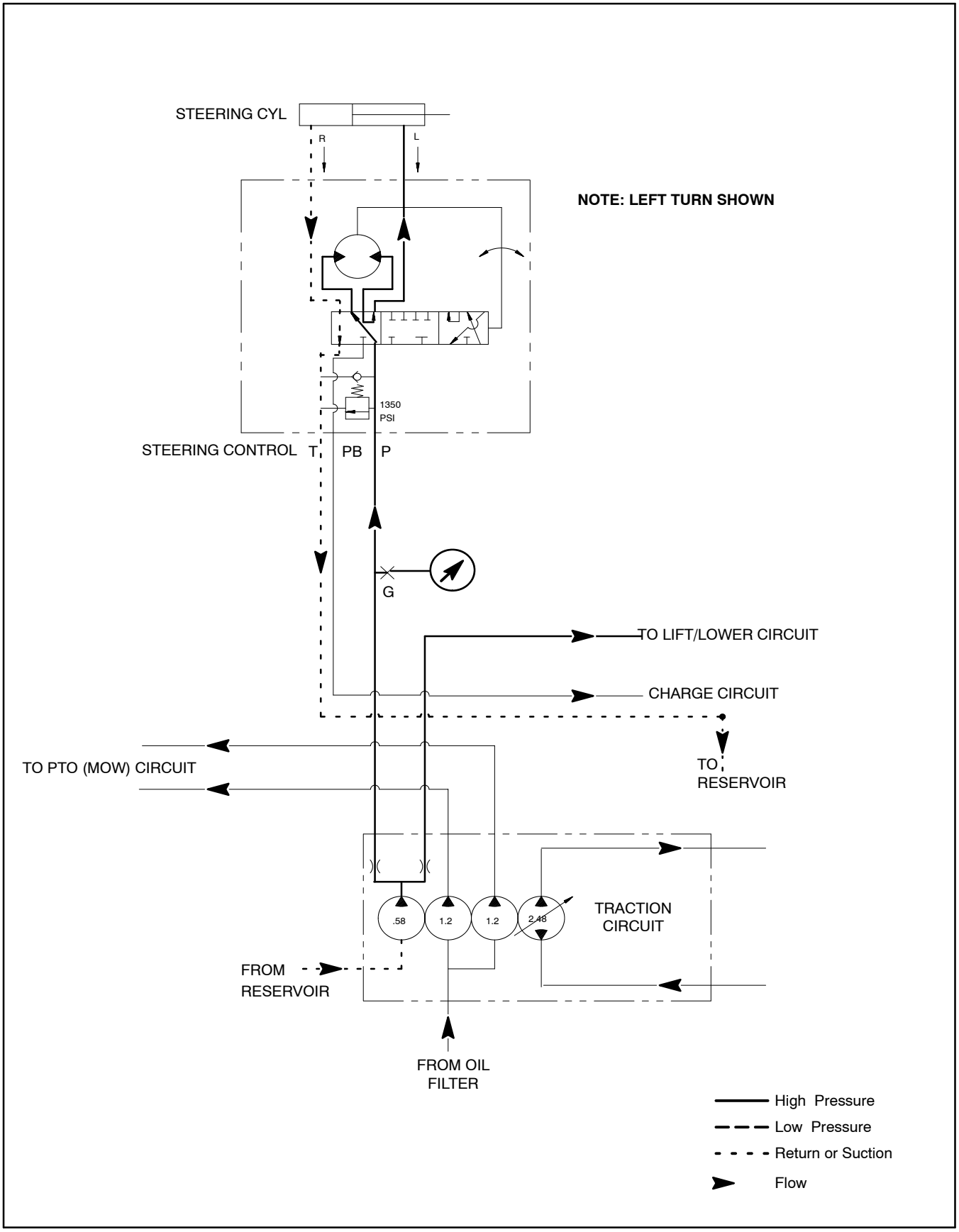


Figure 25

TEST NO. 7: Steering Circuit Relief Pressure (Using Pressure Gauge)



Procedure for Steering Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 5000 PSI gauge onto steering pressure test port.

4. Start the engine and move throttle to full engine speed **(2730 ± 30 RPM)**.

IMPORTANT: Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period will damage the steering motor.

5. Turn steering all the way in one direction and momentarily hold the steering wheel against resistance.

GAUGE READING TO BE **1350 ± 50 PSI**.

6. Stop the engine.

7. If pressure is incorrect, inspect steering relief valve (Fig. 27). If relief valve is operating properly and if lift/lower problems also exist, gear pump should be suspected of wear and inefficiency. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), steering cylinder or steering valve should be suspected of wear or damage.

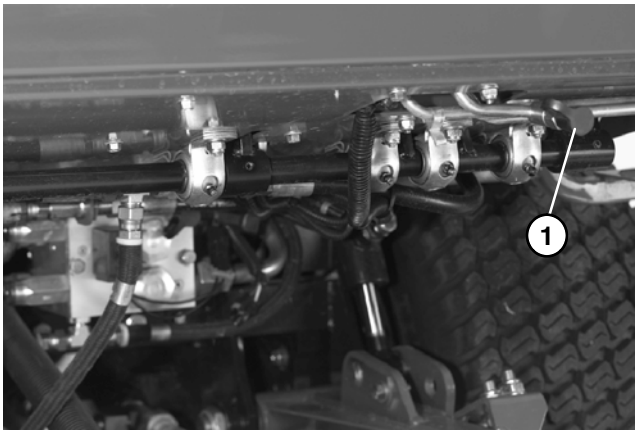


Figure 26

1. Steering circuit pressure test port

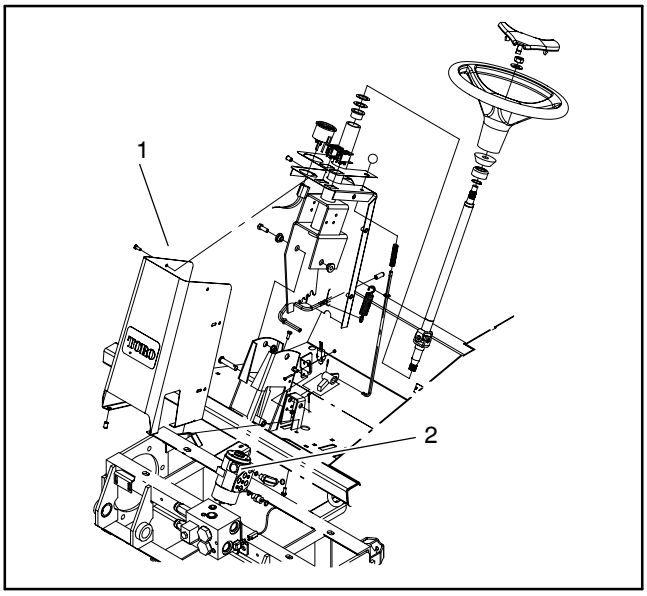
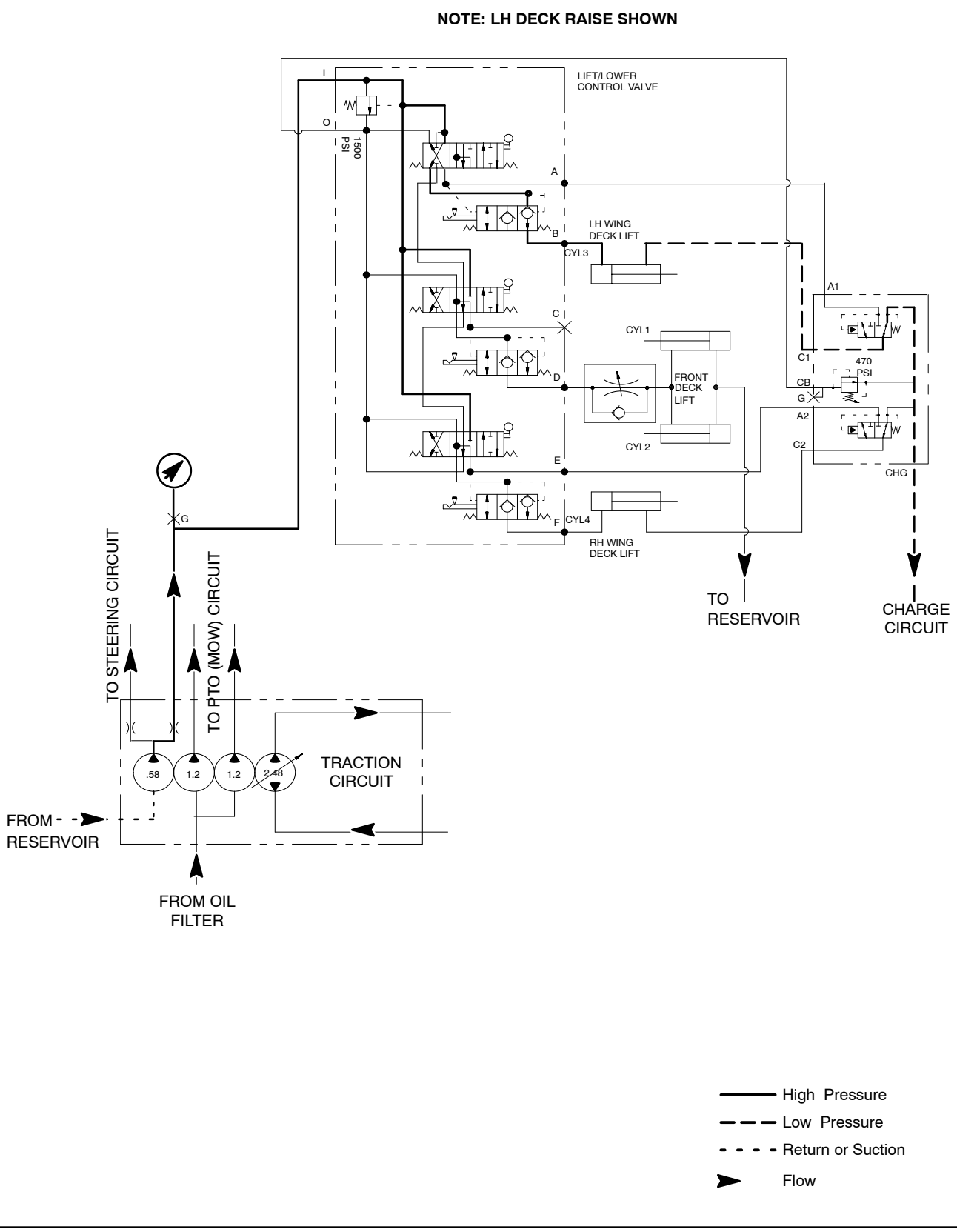


Figure 27

1. Steering tower
2. Steering relief valve

TEST NO. 8: Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)



Procedure for Lift/Lower Circuit Relief Pressure Test

NOTE: Before attempting to check or adjust lift pressure, make sure that counterbalance pressure is correctly adjusted.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Raise seat to gain access to hydraulic test fitting. Connect a 5,000 psi gauge to lift circuit test port (Fig. 28). Route gauge hose to allow seat to be safely lowered.

4. Sit on the seat and start the engine. Move throttle to full speed **(2730 ± 30 RPM)**.

5. While sitting on the seat, pull lift lever back to raise the cutting units. Momentarily hold the lever with the lift cylinder at full extension while looking at the gauge.

GAUGE READING TO BE **1525 to 1575 PSI**.

6. Stop the engine. If pressure is too high, adjust relief valve in lift control valve by rotating counterclockwise (Figure 29). If pressure is too low, check for restriction in pump intake line. Check the lift cylinder for internal leakage. If cylinder is not leaking, adjust the relief valve by rotating clockwise. If pressure is still too low, pump or lift cylinder(s) should be suspected of wear, damage or inefficiency.

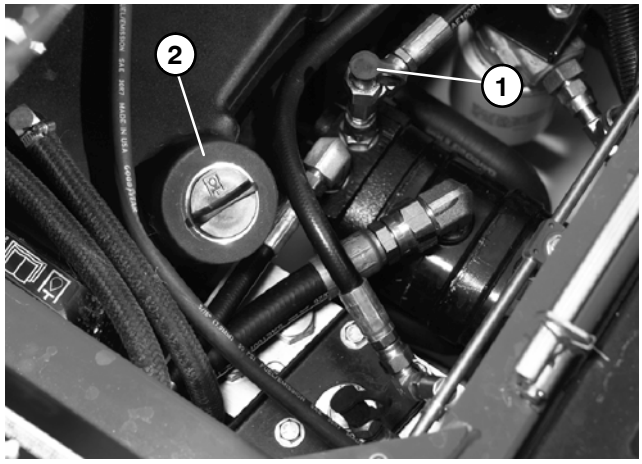


Figure 28

1. **Lift circuit port**
2. **Hydraulic reservoir cap**

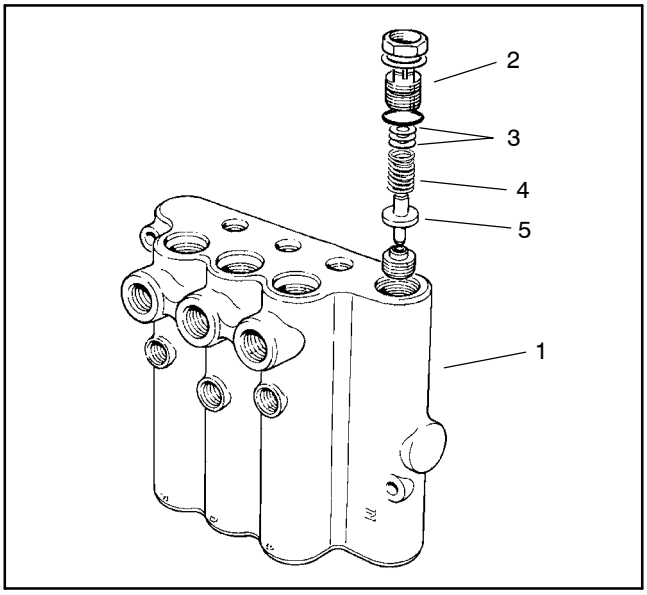
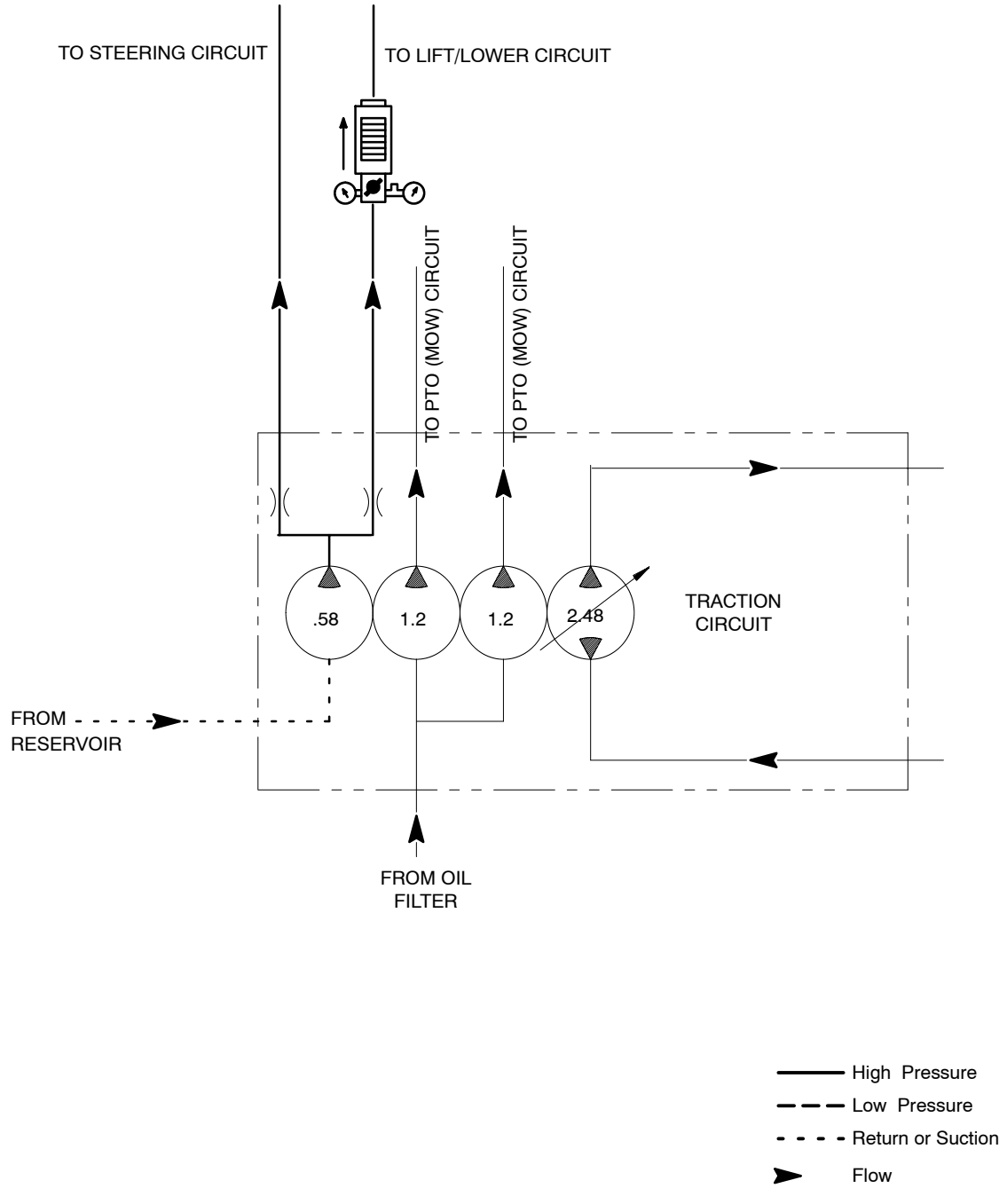


Figure 29

1. **Control valve assembly**
2. **Relief valve assembly**
3. **Washers**
4. **Spring**
5. **Poppet**

TEST NO. 9: Steering and Lift/Lower Gear Pump Flow (Using Tester with Pressure Gauges and Flow Meter)

NOTE: LIFT/LOWER GEAR PUMP FLOW TEST SHOWN



Procedure for Steering and Lift/Lower Gear Pump Flow Test

Output from the steering and lift/lower gear pump section is equally divided by a proportional valve to provide flow to the steering circuit and the lift circuit. To test gear pump flow, testing of both circuits is required. Total gear pump flow is the combined flow from the two circuits.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump, through the tester, and into the hydraulic hose.

3. With the engine off and cutting units lowered, install tester in series between the last gear pump section and one of the circuit hoses (Fig. 30). Make sure the tester flow control valve is OPEN.

IMPORTANT: The pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester, or other components could occur.

4. Start the engine and move throttle to full speed **(2730 ± 30 RPM)**. DO NOT engage the cutting units.

5. While watching pressure gauges, slowly close flow control valve until **1000 PSI** is obtained on gauge. Verify engine speed continues to be correct **(2730 ± 30 RPM)**.

GAUGE READING TO BE: Flow approximately **3.5 GPM** at **1000 PSI**.

6. Stop engine. Remove tester and reinstall hose. Complete steps 3 through 6 for other circuit hose.

7. If the **total** of the two flows is lower than **7 GPM** or a pressure of **1000 PSI** could not be obtained, check for restriction in pump intake line. If intake line is not restricted, remove gear pump and repair or replace as necessary.

If the **total** of the two flows is **7 GPM** but individual circuit flow is less than **3.5 GPM** (e.g.. steering circuit has 2 GPM and lift circuit has 5 GPM), suspect a problem with the proportional valve in the gear pump.

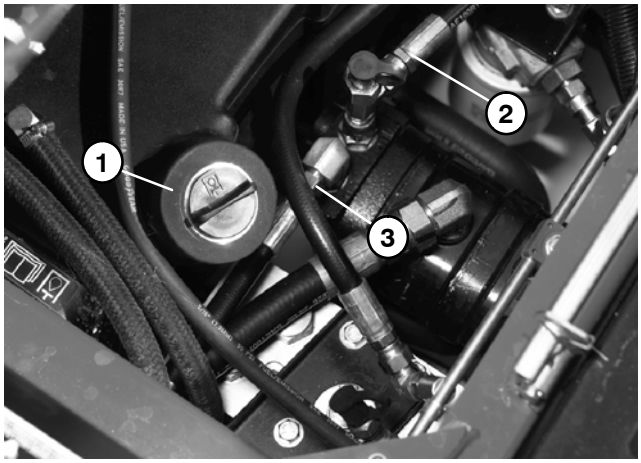


Figure 30

1. **Hydraulic tank cap**
2. **Lift circuit hose**
3. **Steering circuit hose**

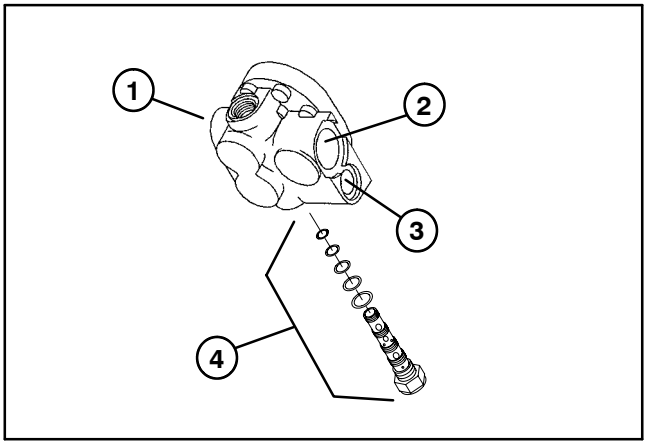
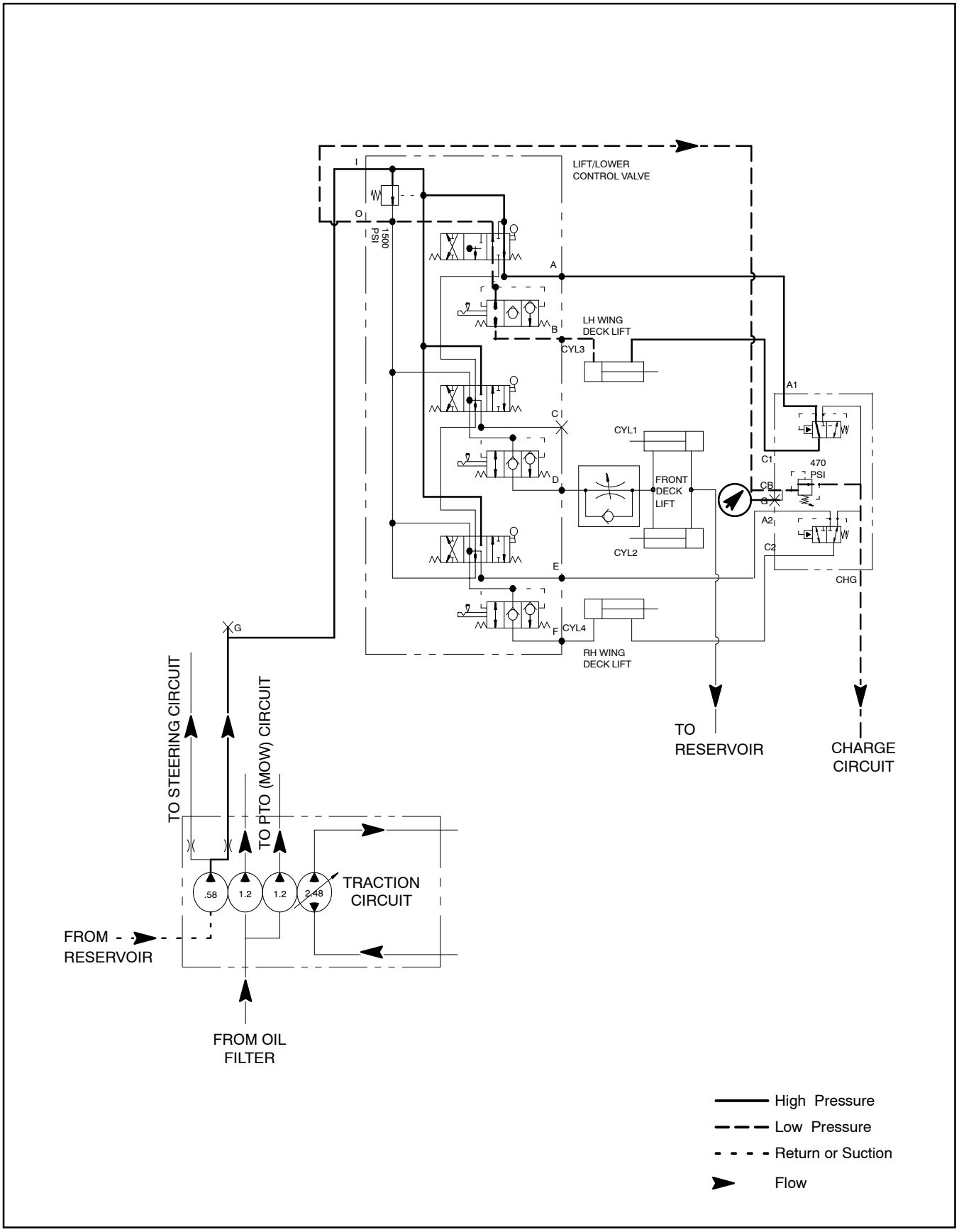


Figure 31

1. **Gear pump backplate**
2. **Lift circuit**
3. **Steering circuit**
4. **Proportional valve**

TEST NO. 10: Counterbalance Pressure (Using Pressure Gauge)



Procedure for Counterbalance Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Determine system charge pressure (see TEST NO. 1: Traction Circuit Charge Pressure in this chapter).

4. Connect a 1000 PSI gauge to counterbalance test port on manifold under console (Fig. 32).

5. Start the engine and put throttle at full engine speed **(2730 ± 30 RPM)** with no load on the system. **Do not engage the cutting units**.

GAUGE READING TO BE **220 PSI (15.2 bar) over system charge pressure** (e.g. if charge pressure is 250 PSI, counterbalance pressure should be 470 PSI)**.**

6. Adjustment of the counterbalance valve can be performed as follows:

NOTE: Do not remove the valve from the hydraulic manifold for adjustment.

A. Loosen locknut on counterbalance valve (Fig. 32).

B. To **increase** pressure setting, turn the adjustment screw on the valve in a clockwise direction. A 1/8 turn on the screw will make a measurable change in counterbalance pressure.

C. To **decrease** pressure setting, turn the adjustment screw on the valve in a counterclockwise direction. A 1/8 turn on the screw will make a measurable change in counterbalance pressure.

D. Tighten locknut to secure adjustment. Check counterbalance pressure and readjust as needed.

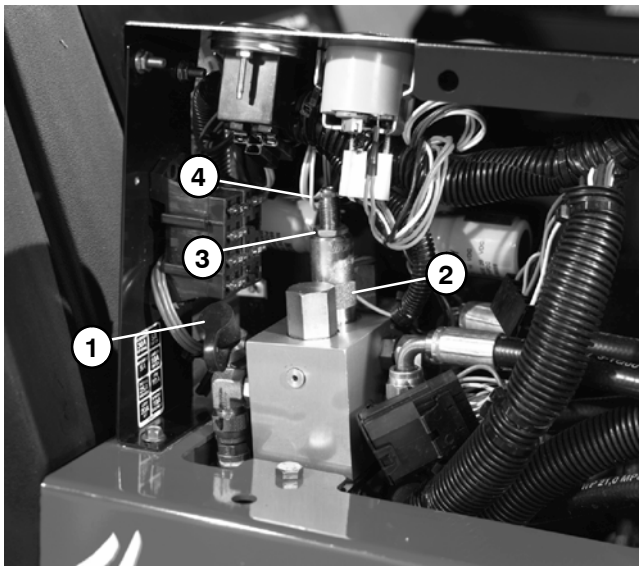
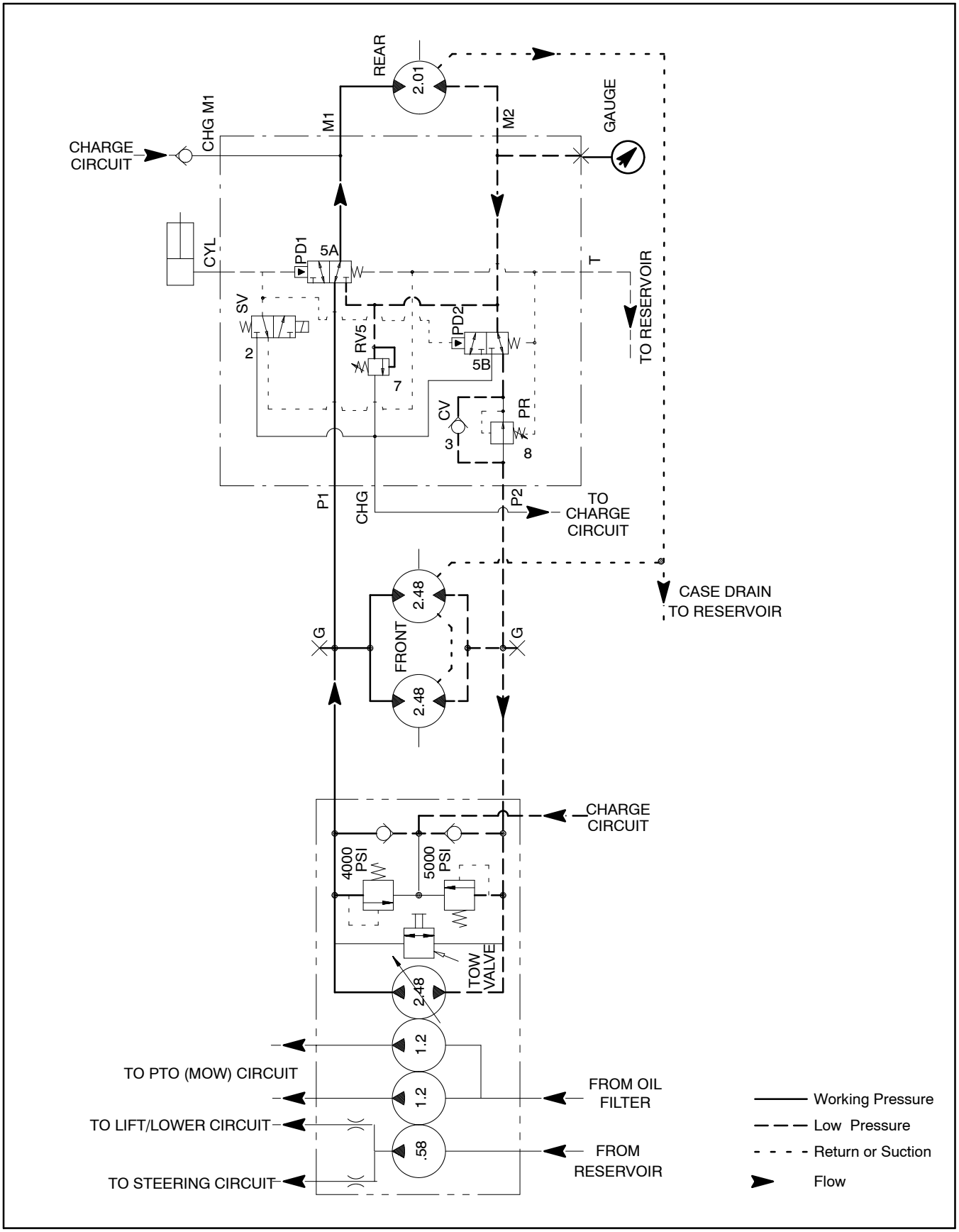


Figure 32

1. Counterbalance test port
2. Counterbalance valve
3. Locknut
4. Adjusting screw

TEST NO. 11: Rear Traction Circuit (RV5) Relief Pressure (Using Pressure Gauge)



Procedure for Rear Traction Circuit (RV5) Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 1000 PSI gauge to test port on 2WD/4WD control manifold under radiator (Fig. 33).

4. Start the engine and put throttle at full engine speed **(2730 ± 30 RPM)**.

5. Operate the machine in 4WD with the cutting units lowered. Drive down a slope in a forward direction, decrease pressure on the traction pedal, and monitor the pressure gauge. Pressure should increase until the relief valve lifts.

GAUGE READING TO BE **750 PSI** (approximate).

6. Relief valve (RV5) is located on the lower, front side of the 2WD/4WD control manifold (Fig. 34). Adjustment of the relief valve can be performed as follows:

NOTE: Do not remove the valve from the hydraulic manifold for adjustment.

A. To **increase** relief pressure setting, remove cap on relief valve and turn the adjustment socket on the relief valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure (Fig. 35).

B. To **decrease** pressure setting, remove cap on relief valve and turn the adjustment socket on the relief valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure (Fig. 35).

C. Recheck relief pressure and readjust as needed.

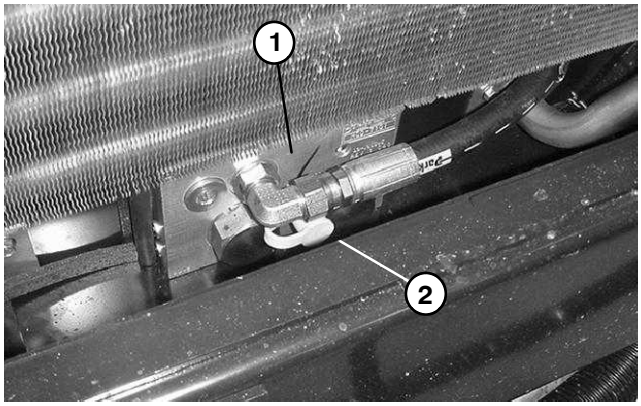


Figure 33

1. **2WD/4WD control manifold**
2. **Relief valve test port**

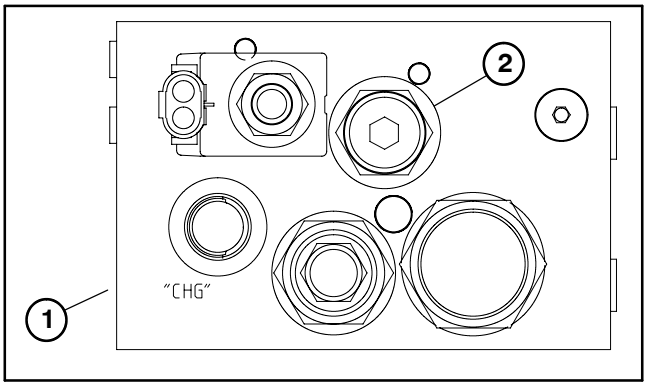


Figure 34

1. **Manifold: lower side**
2. **Relief valve (RV5)**

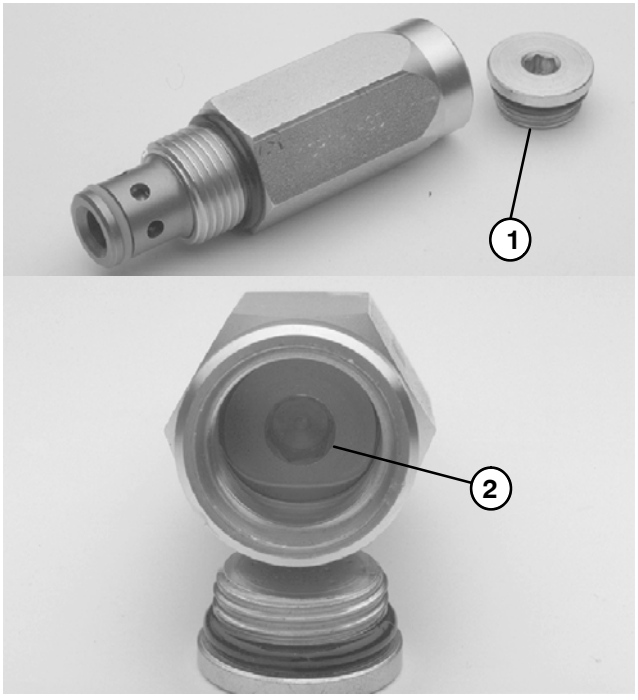
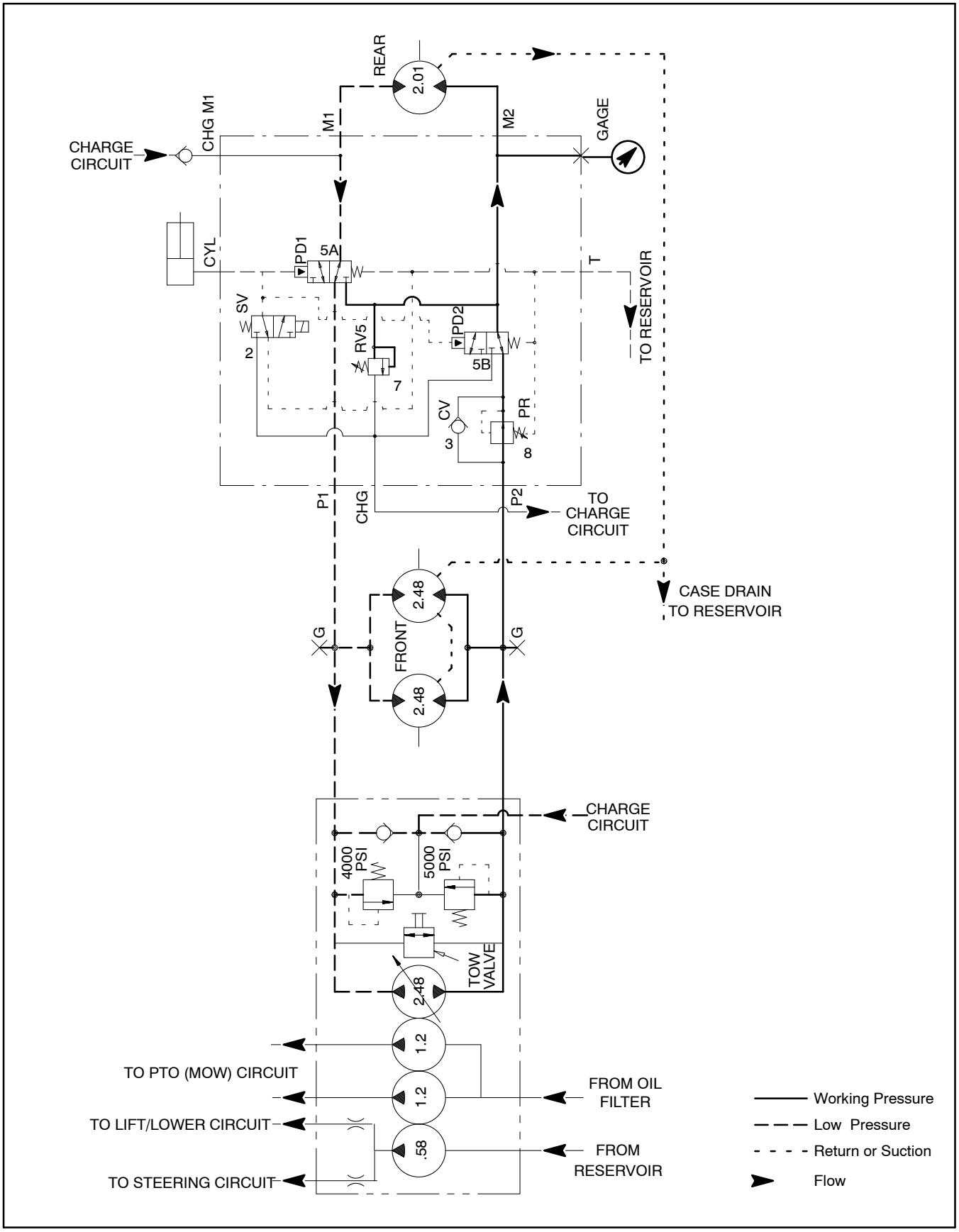


Figure 35

1. **Relief valve cap**
2. **Adjustment socket**

TEST NO. 12: Traction Circuit Reducing Valve (PR) Pressure (Using Pressure Gauge)



Procedure for Traction Circuit Reducing Valve (PR) Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

> **CAUTION**
>
> **Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.**

3. Connect a 1000 PSI gauge to test port on 2WD/4WD control manifold under radiator (Fig. 36).

4. Start the engine and put throttle at full engine speed **(2730 ± 30 RPM)**.

5. Sit on seat, apply brakes fully, and slowly depress the traction pedal in the reverse direction. While pushing traction pedal, look at pressure reading on gauge:

   GAUGE READING TO BE **650 PSI** (approximate).

6. Pressure reducing valve (PR) is located on the lower, front side of the 2WD/4WD control manifold (Fig. 37). Adjustment of this valve can be performed as follows:

NOTE: Do not remove the valve from the hydraulic manifold for adjustment.

   A. To **increase** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.

   B. To **decrease** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.

   C. Recheck pressure setting and readjust as needed.

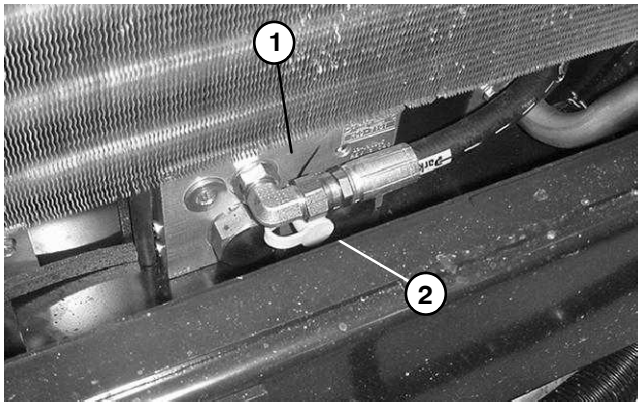


Figure 36

1. **2WD/4WD control manifold**
2. **Pressure test port**

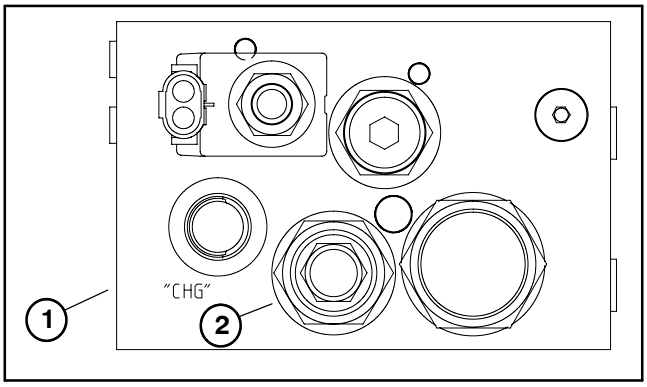


Figure 37

1. **Manifold: lower side**
2. **Reducing valve (PR)**

Adjust Front Cutting Unit Lift Flow Control

The front cutting unit lift circuit is equipped with an adjustable flow control valve used to adjust the rate at which the front deck lowers. Adjust flow control valve as follows:

1. Run machine to get hydraulic oil at operating temperatures. Park machine on a level surface, shut engine off and lower cutting units to the ground.

2. Locate valve under front of machine (Fig. 38).

3. Loosen setscrew on valve and rotate valve clockwise to slow down drop rate of front cutting unit.

4. Verify adjustment by raising and lowering cutting unit several times. Readjust as required.

5. After desired drop rate is attained, tighten setscrew on valve to lock adjustment.

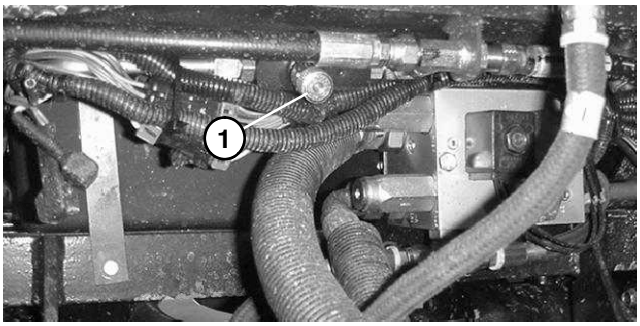


Figure 38

1. **Front cutting unit flow control valve**

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units or attachments, and stop engine. Remove key from the ignition switch.

2. Clean machine before disconnecting, removing, or disassembling any hydraulic components. Make sure hydraulic components, hoses connections, and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in RUN and the engine OFF. Make sure all electrically operated control valves are actuated. Return ignition switch to OFF when pressure has been relieved. Remove key from the ignition switch.

3. Put caps or plugs on any hydraulic lines, hydraulic fittings, and components left open or exposed to prevent contamination.

4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hydraulic hoses and tubes.

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir, and change oil filter if component failure was severe or system is contaminated (see Flush Hydraulic System).

2. Lubricate O−rings and seals with clean hydraulic oil before installing hydraulic components.

3. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings, and components before reconnecting.

4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation).

5. After repairs, check control linkages or cables for proper adjustment, binding, or broken parts.

6. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System).

7. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

IMPORTANT: Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, weather deterioration and chemical deterioration. Make all necessary repairs before operating.

Flush Hydraulic System

IMPORTANT: Flush the hydraulic system any time there is a severe component failure or the system is contaminated (oil appears milky, black, or contains metal particles).

IMPORTANT: Flush hydraulic system when changing from petroleum base hydraulic fluid to a biodegradable fluid such as Mobil EAL 224H. Operate machine under normal operating conditions for at least four (4) hours before draining.

1. Park machine on a level surface. Lower cutting units, stop engine, and engage parking brake. Remove key from the ignition switch.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in OFF. Remove key from the ignition switch.

IMPORTANT: Make sure to clean around any hydraulic connections that will be disconnected for draining.

2. Drain hydraulic reservoir (see Operator's Manual).

3. Drain hydraulic system. Drain all hoses, tubes, and components while the system is warm.

4. Change and replace both hydraulic oil filters (see Operator's Manual).

5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir Inspection).

6. Reconnect all hydraulic hoses, lines, and components that were disconnected while draining system.

NOTE: Use only hydraulic fluids specified in the Operator's Manual. Other fluids may cause system damage.

7. Fill hydraulic reservoir with **new** hydraulic fluid (see Operator's Manual).

8. Disconnect electrical connector from engine run solenoid.

9. Turn ignition key switch; engage starter for 10 seconds to prime pump. Repeat this step again.

10. Connect electrical connector to engine run solenoid.

11. Start engine and let it idle at low speed **(1450 RPM)** for a minimum of 2 minutes. Increase engine speed to high idle **(2730 $\pm$ 30 RPM)** for minimum of 1 minute under no load.

12. Raise and lower cutting units several times. Turn steering wheel fully left and right several times.

13. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct amount of oil if necessary.

14. Operate machine for 2 hours under normal operating conditions.

15. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 14 again until oil is clean. If changing to biodegradable fluid, repeat steps 1 through 14 again at least once and until the oil is clean.

16. Assume normal operation and follow recommended maintenance intervals.

Charge Hydraulic System

NOTE: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps, or lift cylinders, it is important that the hydraulic system be charged properly. Air must be purged from the system and its components to reduce the chance of damage.

IMPORTANT: Change hydraulic oil filter whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface. Lower cutting units, stop engine, and engage parking brake. Remove key from the ignition switch.

2. Make sure all hydraulic connections, lines, and components are secured tightly.

3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and tank (see Flush Hydraulic System).

4. Make sure hydraulic reservoir is full. Add correct hydraulic oil if necessary (see Operator's Manual).

5. Disconnect engine run solenoid lead to prevent the engine from starting.

6. Check control rod to the piston (traction) pump for proper adjustment, binding, or broken parts.

7. Make sure traction pedal and lift control lever are in the **neutral** position. Turn ignition key switch; engage starter for **fifteen (15) seconds** to prime the traction and gear pumps.

8. Reconnect engine run solenoid lead.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 – Safety.

9. Raise one front and one rear wheel off the ground, and place support blocks under the frame. Chock remaining wheels to prevent movement of the machine.

10. Make sure traction pedal and lift control lever are in **neutral**. Start engine and run it at low idle **(1450 rpm)**. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in **30 seconds**, stop the engine and determine the cause.

11. After the hydraulic system starts to show signs of fill, actuate lift control lever until the lift cylinder rod moves in and out several times. If the cylinder rod does not move after **10 to 15 seconds**, or the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:

    A. Loose filter or suction lines.

    B. Blocked suction line.

    C. Faulty charge relief valve.

    D. Faulty gear pump.

12. If cylinder does move in **10 to 15 seconds**, proceed to step 13.

13. Operate the traction pedal in the forward and reverse directions. The wheels off the ground should rotate in the proper direction.

    A. If the wheels rotate in the wrong direction, stop engine, remove lines from bottom of piston (traction) pump, and reverse the connections.

    B. If the wheels rotate in the proper direction, stop engine.

14. Adjust traction pedal to the neutral position (see Operator's Manual).

15. Check operation of the traction interlock switch (see Check Interlock System in Chapter – 5, Electrical Systems).

16. Remove blocks from frame and lower machine. Remove chocks from remaining wheels.

17. If the piston (traction) pump or a traction motor was replaced or rebuilt, run the machine so all wheels turn slowly for 10 minutes.

18. Operate machine by gradually increasing its work load to full over a 10 minute period.

19. Stop the machine. Check hydraulic reservoir and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

Gear Pump

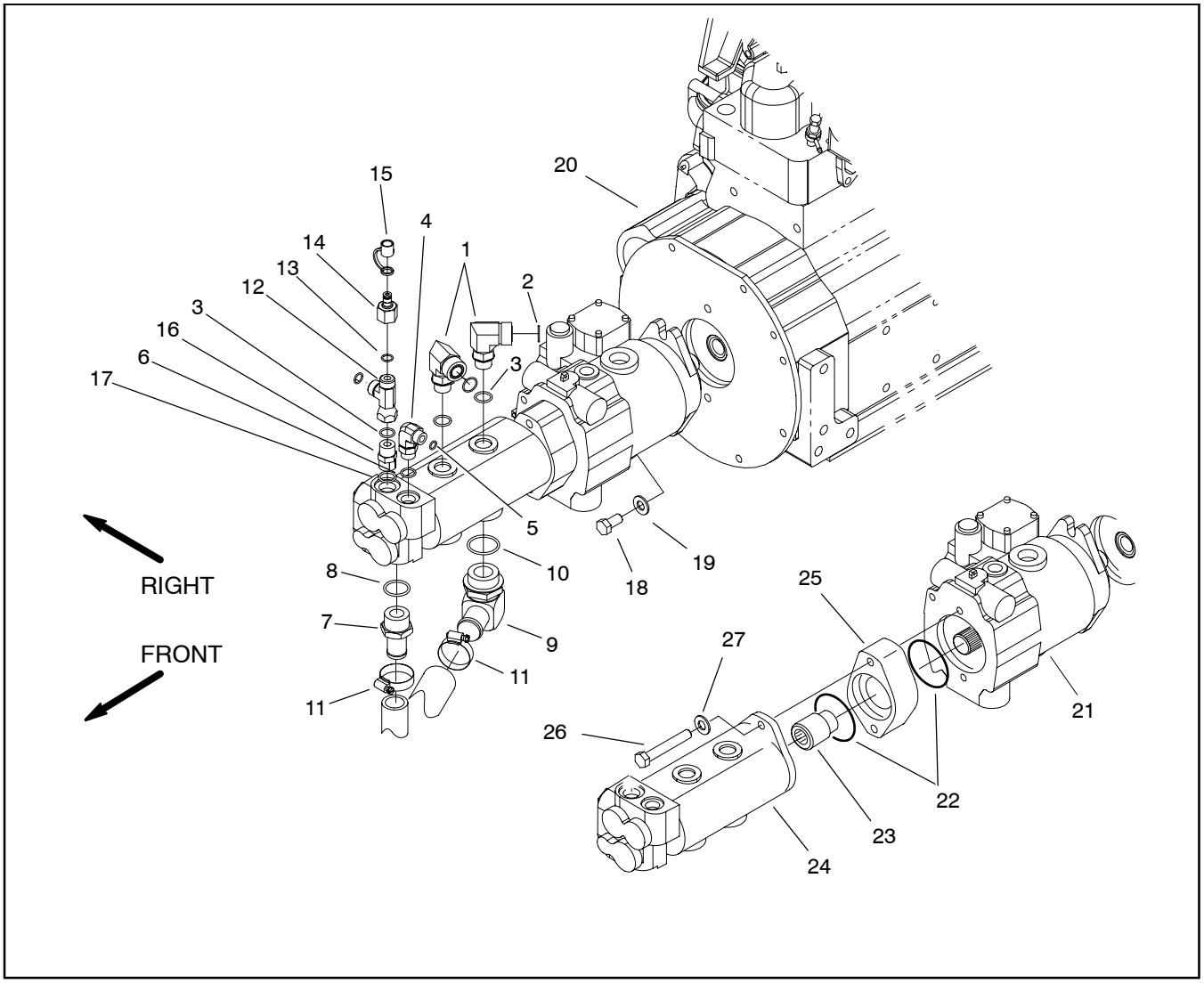


Figure 39

1. 90º hydraulic fitting
2. O-ring
3. O-ring
4. 90º hydraulic fitting
5. O-ring
6. O-ring
7. Hydraulic fitting
8. O-ring
9. Hydraulic fitting
10. O-ring
11. Clamp
12. Hydraulic T fitting
13. O-ring
14. Hydraulic fitting
15. Fitting cap
16. Hydraulic fitting
17. O-ring
18. Cap screw
19. Flat washer
20. Engine
21. Piston pump
22. O-ring
23. Coupler
24. Gear pump
25. Spacer
26. Cap screw
27. Washer

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Raise seat and secure it with prop rod to gain access to gear pump.

3. Drain the hydraulic reservoir (see Operator's Manual).

4. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump and fittings.

5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

6. Disconnect hydraulic lines from pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

7. Support gear pump assembly to prevent it from falling.

8. Remove two (2) cap screws and washers securing gear pump to piston pump. Remove gear pump, coupler, spacer, and o−rings from machine.

Installation

1. Lubricate new o−rings with clean hydraulic oil and position on pump.

2. Slide coupler onto the piston pump output shaft.

3. Position o−rings and spacer to gear pump. Align gear teeth and slide gear pump input shaft into coupler. Secure gear pump to piston pump with two (2) cap screws and washers.

4. Remove caps or plugs from hydraulic lines and fittings. Install lines to gear pump.

5. Replace hydraulic filter and fill hydraulic reservoir with new hydraulic oil.

6. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime the hydraulic pump by turning the ignition key switch to start and crank the engine for 10 seconds. Repeat cranking procedure again.

7. Connect engine run solenoid electrical connector, start the engine and check for proper operation.

8. Properly fill hydraulic system (see Charge Hydraulic System).

9. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Gear Pump Service

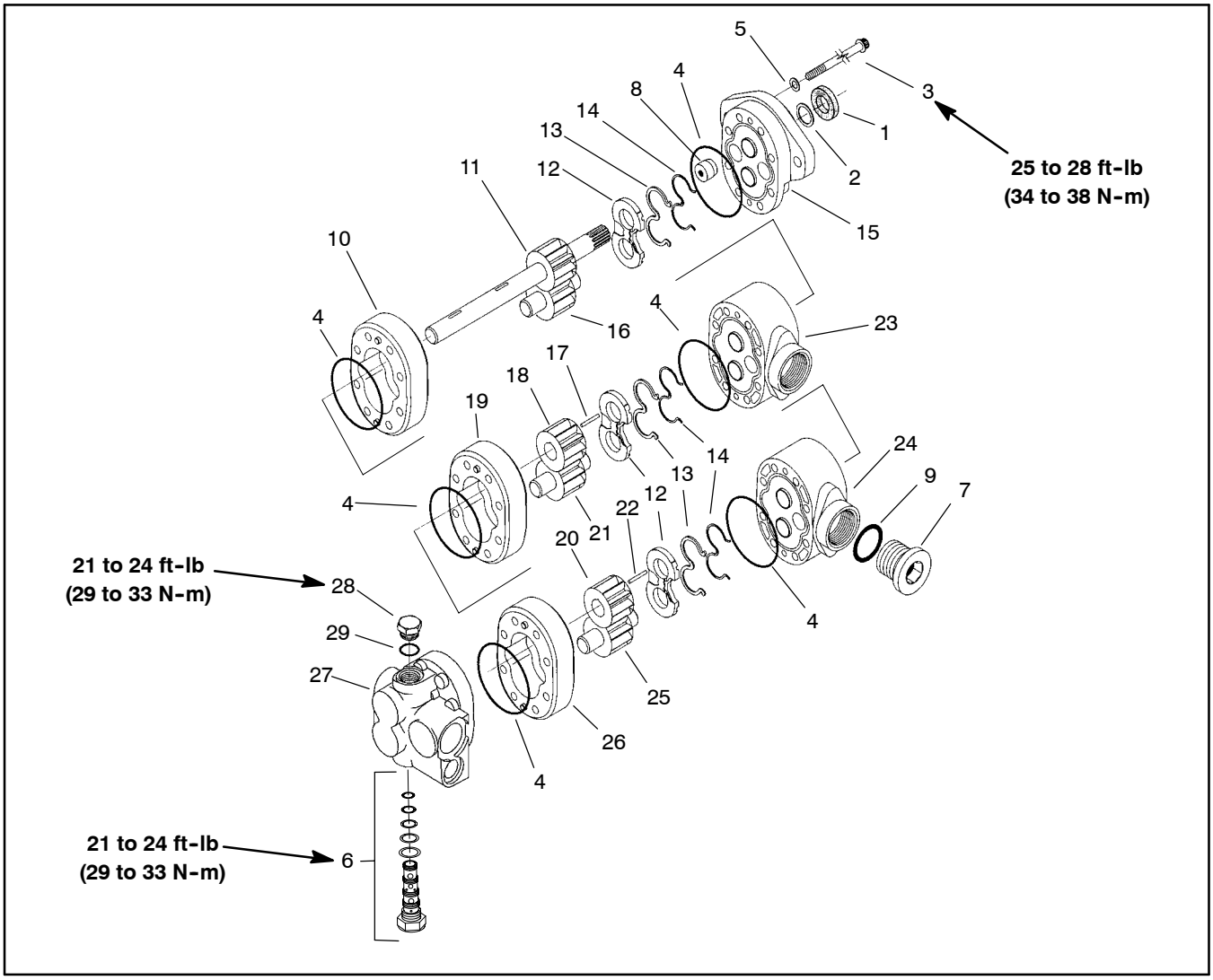


Figure 40

1. Shaft seal
2. Washer
3. Cap screw
4. O-ring
5. Washer
6. Proportional valve
7. Plug
8. Plug
9. O-ring
10. Front body
11. Drive gear assembly
12. Wear plate
13. Pressure seal
14. Backup gasket
15. Front plate assembly
16. Idler gear
17. Key
18. Gear
19. Middle body
20. Gear
21. Idler gear
22. Key
23. Front adapter plate
24. Rear adapter plate
25. Idler gear
26. Rear body
27. Backplate assembly
28. Plug
29. O-ring

Disassembly

Work in a clean area as cleanliness is extremely important when repairing hydraulic pumps. Thoroughly clean the outside of pump. After cleaning, remove port plugs and drain oil from pump.

1. Scribe a line, at an angle, across front plate (15), bodies (10, 19, 26), adapter plates (23, 24) and backplate (27). This will assure proper reassembly.

NOTE: To maintain maximum pump efficiency, keep body, gears and wear plates for each section together. **DO NOT** mix parts between different sections.

IMPORTANT: Avoid using excessive clamping pressure on the pump housing to prevent distorting the housing.

2. Clamp pump in vise, shaft end up and remove the eight cap screws (3).

3. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front pump sections. Front body (10) will remain with either front plate (15) or front adapter plate (23).

4. Place front idler gear (16) into gear pocket and tap with soft face hammer until the front body separates. Remove idler gear from front plate or adapter plate.

5. Remove plug (8) from front plate (15).

6. Remove front adapter plate (23) from front body (10) by tapping on the adapter plate with a soft face hammer.

7. Remove idler gear (21), slip fit gear (18), and key (17).

8. Remove backplate (27) from rear body (26) by tapping on backplate with soft face hammer.

9. Remove rear idler gear (25), slip fit gear (20) and key (22).

10. Remove drive gear assembly (11) from rear adapter plate (24).

11. Place rear idler gear assembly (25) back into gear pocket and tap protruding end with soft face hammer to remove rear body (26) from the backplate assembly (27) or the rear adapter plate (24).

IMPORTANT: Note position of the open and closed side of the wear plates before removing.

12. Remove the wear plates (12) and o−rings (4) from front plate (15), front adapter plate (23), and rear adapter plate (24).

13. Remove backup gaskets (14) and pressure seals (13) from wear plates (15) by carefully prying out with a sharp tool.

IMPORTANT: Do not damage the seal bore in the front plate during seal removal.

14. Remove shaft seal (1) and washer (2) from front plate (15).

15. Remove plug (7) and washer (9) from rear adapter plate (24).

16. Remove proportional valve (6) from backplate assembly (27).

Inspection

1. Clean and dry all pump components. Remove nicks and burrs from all parts with emery cloth.

2. Check spline drive shaft for twisted or broken teeth. Also check for damaged keyway, on drive shaft, that drives the slip fit gears of the pump.

3. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.

4. Replace gear assembly if shaft measures less than .873 inch (22.17mm) in bushing area. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only. The slip fit gear is available separately).

5. Inspect gear faces for scoring or excessive wear.

6. Replace gear assembly if gear width is below 1.181 inch (30.00 mm).

7. Assure that snap rings are in grooves on either side of drive and idler gears.

8. If any edge of gear teeth is sharp, break edge with emery cloth.

9. Oil groove in bushings in front plate, backplate and adapter plates should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to respective dowel pin holes.

10. Replace the backplate, front plate or adapter plates if I.D. of bushings exceed .879 inch (22.33mm) (Bushings are not available as separate items).

11. Bushings in front plate and backup gasket side of adapter plates should be flush with face of plate.

12. Check for scoring on face of backplate and adapter plates. Replace if wear exceeds .0015 inch (.038mm).

13. Check bodies inside gear pockets for excessive scoring or wear.

14. Replace bodies if I.D. of gear pockets exceeds 2.100 inch (53.34mm).

Reassembly

It is important that the relationship of the backplate, adapter plates, bodies, wear plates and front plate is correct. The two half moon cavities in the bodies must face away from the front plate or adapter plate. The smaller half moon port cavity must be on the pressure side of the pump. The side of the wear plate with mid section cut out must be on suction side of pump. Suction side of backplate or adapter plate is always the side with larger port boss.

1. Replace the wear plates, pressure seals, backup gaskets, shaft seal and o-rings as new parts. During reassembly, check the scribe mark on each part to make sure the parts are properly aligned.

2. Install o-rings (4) in groove of front plate (15), adapter plates (23, 24), and backplate (27) with a small amount of petroleum jelly to hold in place.

3. Install new pressure seals (13) and backup gaskets (14) into new wear plates (12). The flat section in the middle of the backup gasket must face away from the wear plate inside the seal.

4. Place plug (8) into pocket of front plate (15).

5. Apply a thin coat of petroleum jelly to both milled gear pockets of front body (10). Position body onto front plate (15) with half moon port cavities in body facing away from front plate.

NOTE: The small half moon port cavity must be on the pressure side of pump.

6. Place wear plate (12) into the gear pocket with the pressure seal and backup gasket against the front plate. The side with the mid section cut away must be on suction side of pump.

7. Dip drive gear assembly (11) and idler gear assembly (16) into clean hydraulic oil. Slip both gear assemblies into gear pocket of front body (10) and into front plate bushings.

8. Install front adapter plate (23) in place on front body (10). Check positioning marks for correct orientation.

9. Install middle body (19) onto front adapter plate (23). Place wear plate (12) into the gear pocket with the pressure seal and backup gasket against the front adapter plate.

10. Install key (17) in slot of drive gear shaft. Dip slip fit gear (18) in clean hydraulic oil and slide on shaft and into gear pocket of middle body (19). Check key for proper alignment.

11. Dip idler gear (21) in clean hydraulic oil and install in gear pocket of middle body.

12. Install rear adapter plate (24) in place on middle body (19). Check positioning mark on all sections of pump.

13. Position rear body (26) onto rear adapter plate (24). Place wear plate (12) into the gear pocket with the pressure seal and backup gasket against the rear adapter plate.

14. Install key (22) in slot of drive gear shaft. Dip slip fit gear (20) in clean hydraulic oil and slide on shaft and into gear pocket of rear body (26). Check key for proper alignment.

15. Dip rear idler gear (25) in clean hydraulic oil and install in gear pocket of rear body.

16. Position backplate (27) over shafts until dowel pins in body are engaged.

17. Secure pump components with cap screws (3). Torque cap screws evenly in a crisscross pattern from 25 to 28 ft-lb (34 to 38 N-m).

18. Place washer (2) over drive shaft into housing. Liberally oil shaft seal (1) and install over drive shaft carefully so that rubber sealing lips are not cut.

19. Place 1-3/8" O.D. sleeve over shaft and press in shaft seal .200 in. (5.08mm) below surface of front plate.

20. Install plug (7) and washer (9) into rear adapter plate.

21. If removed, install plug (28) with o-ring into backplate and torque from 21 to 24 ft-lb (29 to 33 N-m).

22. Install proportional valve (6) into backplate. Torque plug from 21 to 24 ft-lb (29 to 33 N-m).

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Piston (Traction) Pump

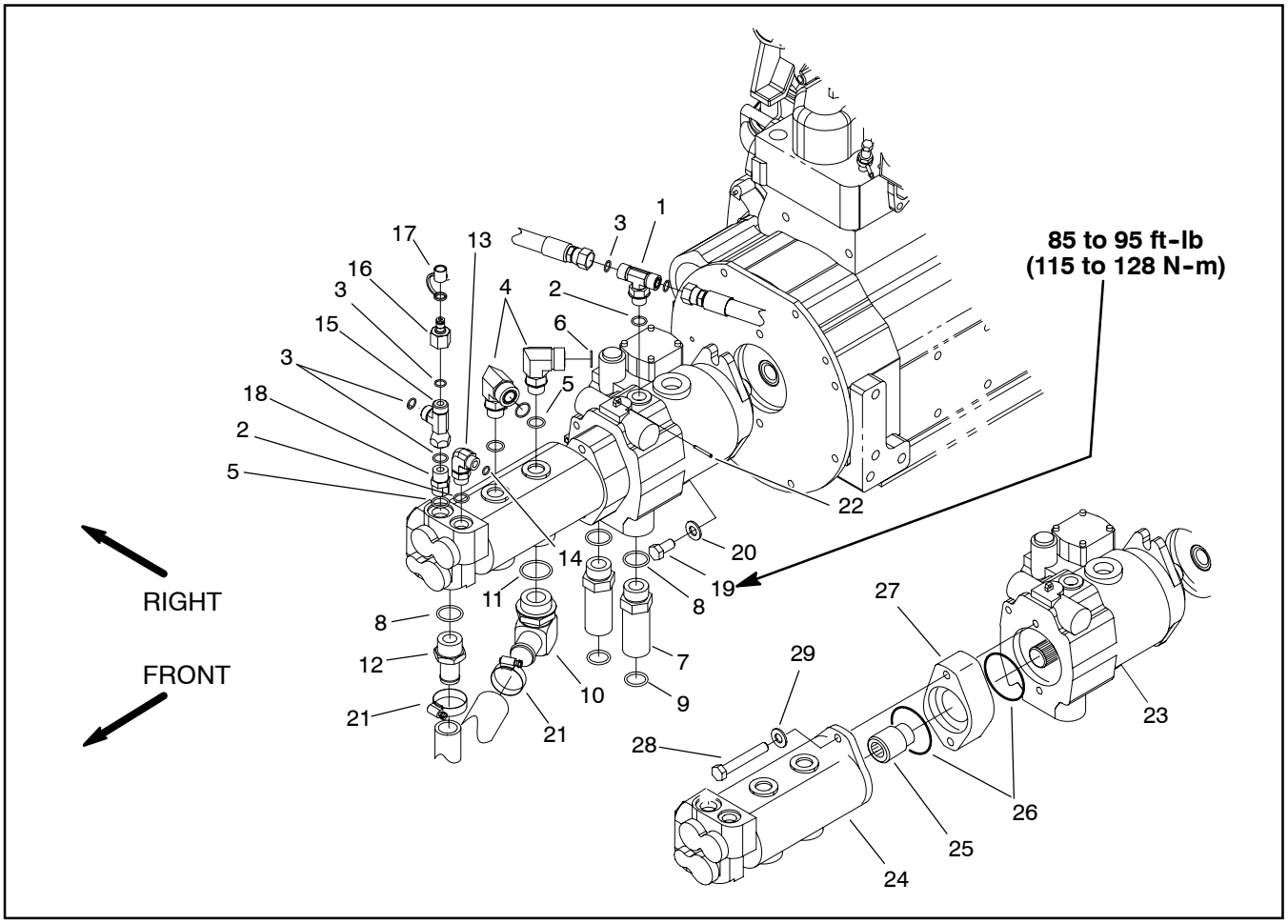

Figure 41

1. Hydraulic T fitting
2. O-ring
3. O-ring
4. 90º hydraulic fitting
5. O-ring
6. O-ring
7. Hydraulic fitting
8. O-ring
9. O-ring
10. Hydraulic fitting
11. O-ring
12. Hose connector
13. 90º hydraulic fitting
14. O-ring
15. Hydraulic T fitting
16. Hydraulic fitting
17. Fitting cap
18. Hydraulic fitting
19. Cap screw
20. Flat washer
21. Clamp
22. Roll pin
23. Piston pump
24. Gear pump
25. Coupler
26. O-ring
27. Spacer
28. Cap screw
29. Washer

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump assembly.

3. Remove traction rod from control arm on piston pump by removing lock nut, spacer and cap screw.

4. Disconnect two wires from neutral switch on traction pump.

5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

6. Put a drain pan below the pump assembly. Remove hydraulic hoses and fittings connected to piston and gear pumps. Put plugs or caps on disconnected hydraulic hoses to prevent contamination of the system. Put plugs in open ports of pumps.

7. Remove gear pump from machine (see Gear Pump Removal). Note: If fuel tank is loosened and raised from the machine, the gear pump and piston pump can be removed as a complete assembly.

8. Support the piston pump to prevent it from falling while removing two (2) cap screws and washers retaining pump assembly to engine adapter plate. Carefully pull pump assembly from adapter plate and raise it out of the machine.

Installation

1. Carefully lower piston pump into the machine and position it to the engine adapter plate. Support pump to prevent it from falling while installing two (2) cap screws and washers securing piston pump to engine adapter plate. Torque screws from 85 to 95 ft–lb (115 to 128 N–m).

2. Install gear pump to piston pump (see Gear Pump Installation).

3. Position traction rod to control arm on piston pump by installing cap screw, spacer and lock nut.

4. Connect two wires to neutral switch on traction pump.

5. Remove plugs or caps from disconnected hydraulic hoses and open ports of the pump assembly. Install fittings and hoses to correct location on gear and piston pumps.

6. Install new filter and fill hydraulic reservoir with correct oil.

7. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime pumps by turning ignition key switch to crank engine for 10 seconds. Repeat cranking procedure again.

8. Connect engine run solenoid electrical connector, start the engine, and check for proper operation.

9. Properly fill hydraulic system (see Charge Hydraulic System).

10. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Piston (Traction) Pump Service

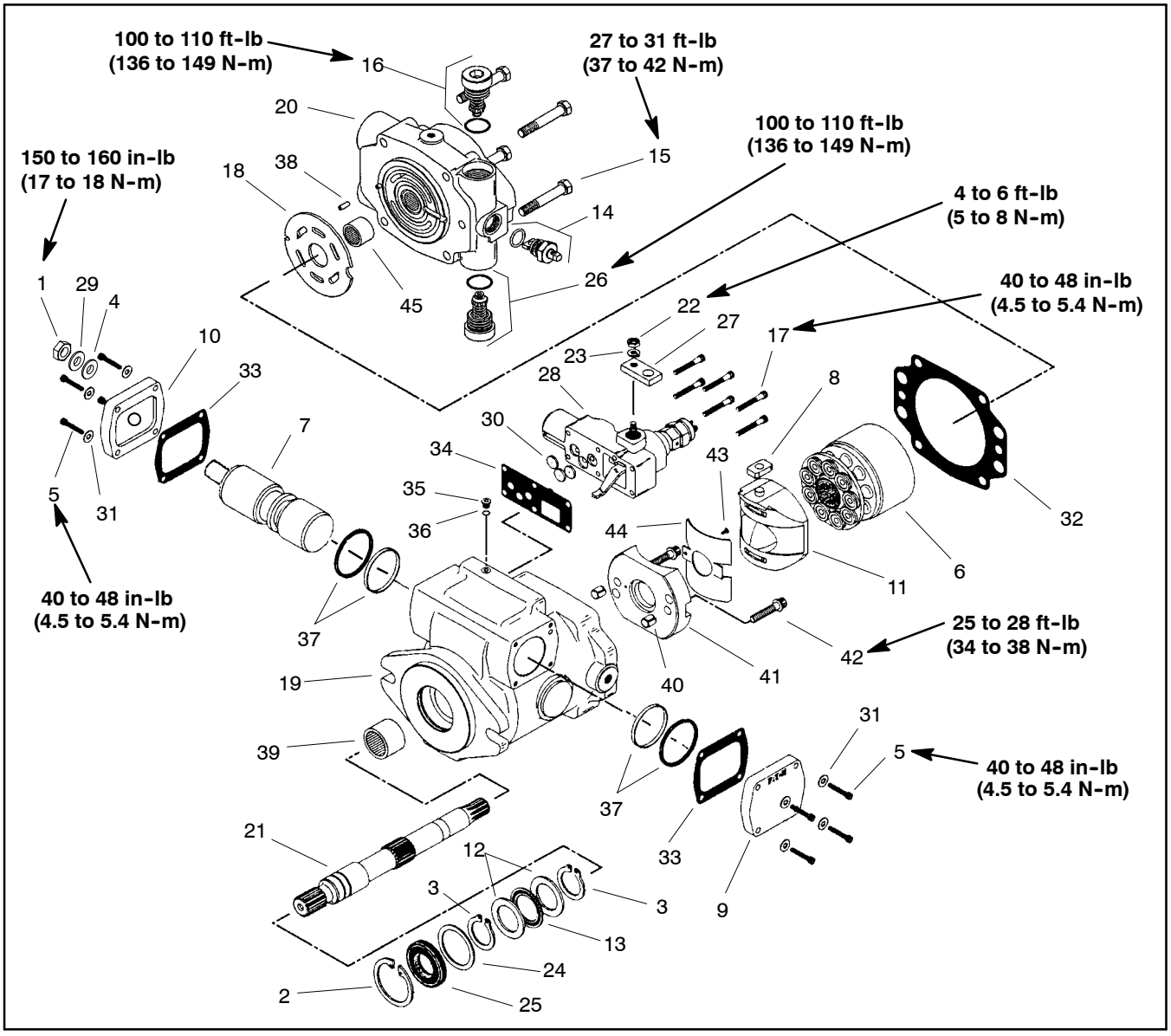
100 to 110 ft-lb
(136 to 149 N-m)
27 to 31 ft-lb
(37 to 42 N-m)
100 to 110 ft-lb
(136 to 149 N-m)
150 to 160 in-lb
(17 to 18 N-m)
4 to 6 ft-lb
(5 to 8 N-m)
40 to 48 in-lb
(4.5 to 5.4 N-m)
40 to 48 in-lb
(4.5 to 5.4 N-m)
25 to 28 ft-lb
(34 to 38 N-m)
40 to 48 in-lb
(4.5 to 5.4 N-m)

Figure 42

1. Jam nut
2. Retaining ring
3. Retaining ring
4. Seal washer
5. Socket head screw
6. Rotating kit assembly
7. Servo piston assembly
8. Piston follower
9. Cover plate
10. Cover plate
11. Camplate assembly
12. Thrust race
13. Thrust bearing
14. Bypass valve
15. Cap screw
16. Relief valve (Reverse)
17. Socket head screw
18. Valve plate
19. Pump housing
20. Backplate assembly
21. Drive shaft
22. Nut
23. Lock washer
24. Washer
25. Shaft seal
26. Relief valve (Forward)
27. Control arm
28. Servo control assembly
29. Washer
30. Orifice plate (3 used)
31. Flat washer
32. Housing gasket
33. Cover plate gasket
34. Control assembly gasket
35. Plug
36. O-ring
37. Seal sub-assembly
38. Roll pin
39. Bearing
40. Dowel bushing
41. Cradle sub-assembly
42. Cap screw
43. Button head cap screw
44. Bushing
45. Bearing

Disassembly

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the cap screws up. Mark the relationship of the working ports (for reassembly identification) to the servo control assembly with a scribe. Remove the four cap screws (15) retaining backplate (20).

2. Lift backplate (20) straight up off drive shaft (21) and housing (19). Remove valve plate (18) from backplate (20) or from rotating kit assembly (6), still in housing (19).

3. From backplate (20), remove bypass valve (14), forward relief valve (26), and reverse relief valve (16). Note: Mark the valves in relationship to the cavity it was removed, for reassembly purposes.

4. Remove housing gasket (32) from housing (19) or backplate (20).

5. With pump still in vise, remove the six socket head screws (17) retaining the servo control assembly (28). Remove the control assembly and control housing gasket (34) from the housing. Remove orifice plates (30), noting location for reassembly. Remove nut (22), lock washer (23), and control arm (27) from servo control input shaft. Note position of control arm for reassembly.

6. To remove rotating kit assembly (6) from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing (19) and drive shaft (21) from rotating kit assembly (6) and camplate assembly(11).

7. Remove camplate (11) from rotating kit assembly (6) and servo piston follower (8) from camplate (11).

8. Remove the four socket head screws (5) and washers (31) retaining each cover plate (9 & 10).

9. Remove jam nut (1), washer (29), and seal washer (4). Hold the servo piston bolt with hex key and unscrew cover plate (10) from bolt.

10. Remove servo piston assembly (7) and seal sub–assemblies (two sets) (37) from housing. Note: Disassembly of servo piston assembly is not required.

11. Remove retaining ring (2) from the front of pump housing (19). Press the drive shaft (21), shaft seal (25), and washer (24) from housing. Remove retaining ring (3), thrust race (12), thrust bearing (13), second thrust race (12), and second retaining ring (3) from drive shaft (21).

12. Remove the two cap screws (42) that secure cradle sub–assembly inside housing. Move the cradle sub–assembly back–and–forth to release dowel bushings (40) and remove cradle sub–assembly from housing.

13. Remove button head cap screw (43) to remove bushing (44) from cradle.

14. Remove remaining plugs from housing.

15. Discard the shaft seal (25), gaskets (32, 33, 34), and o–rings from all assemblies. Replace with new seals upon reassembly.

Inspection

1. Inspect backplate assembly:

   A. Check the bearing (45) (press fit) in backplate (20). If needles remain in cage, move freely, and setting is at the dimension shown in Figure 43, bearing removal is not required.

   B. Check roll pin (38) in backplate (20). If tight and set to the dimension shown in Figure 43, removal not required.

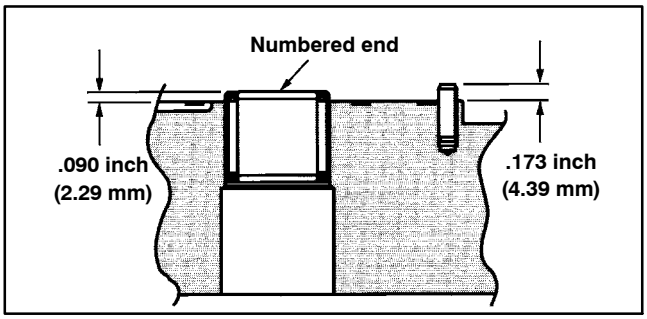

Figure 43

2. Check the bearing (39) (press fit) in pump housing (19). If needles remain in cage, move freely, and setting at the dimension shown in Figure 44, bearing removal is not required.

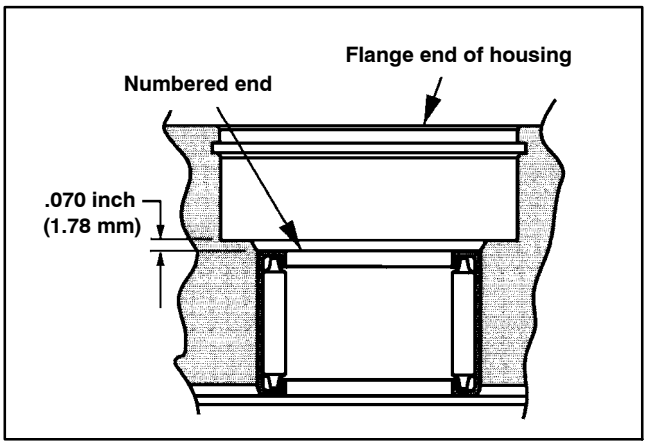

Figure 44

3. Inspect camplate assembly:

A. The finish on the piston shoe surfaces of the camplate (11) should show no signs of scoring.

B. Inspect camplate (11) bushing surface for wear. Also inspect surface for coating transfer from bushing.

4. Inspect bushing (44) for contamination embedment within coating of bushing surface coming in contact with camplate (11).

5. Inspect rotating kit (Fig. 45):

A. The pistons should move freely in the rotating kit piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.

B. Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**

C. Examine the spider for wear in the pivot area.

D. Examine the spider pivot to insure smoothness and no signs of wear.

Reassembly

1. All parts should be cleaned and internal pump parts lubricated with clean hydraulic oil before reassembly.

2. If necessary, press new bearing into pump housing to dimension shown in Figure 44 with the numbered end of bearing outward.

3. Install the two new seal sub-assemblies (37) into the servo piston cavity of pump housing (19).

4. Screw the cover plate (10) onto the servo piston assembly (7). Install new cover plate gasket (33) in place on pump housing. Install servo piston assembly (7) and cover plate (10) into servo piston bore in right side of housing (Fig. 46). Retain cover plate with four washers (31) and socket head screws (5). Torque screws from 40 to 48 in-lb (4.5 to 5.4 N-m). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston .500 in. (12.7 mm) from surface of housing servo bore as shown in Figure 46.

NOTE: Re-adjustment may be required for neutral at unit start-up.

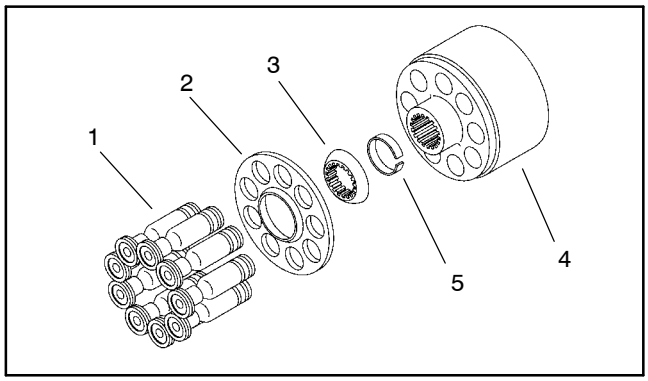

Figure 45

1. **Piston assemblies**
2. **Spider**
3. **Spider pivot**
4. **Piston block**
5. **Retainer**

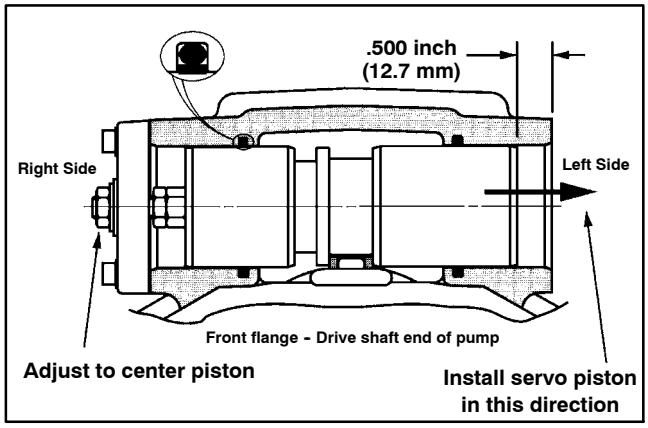

Figure 46

5. Install new seal washer (4), washer (29), and jam nut (1) to servo piston bolt. Holding servo piston bolt with hex key wrench, torque jam nut from 150 to 160 in-lb (17 to 18 N-m). Check the centering of servo piston assembly (7). Install new cover plate gasket (33) and cover plate (9) to open side of servo piston and retain with four washers (31) and socket head screws (5). Torque screws from 40 to 48 in-lb (4.5 to 5.4 N-m).

6. Press dowel bushings (40) into cradle and secure bushing (44) onto cradle with button head cap screw (43). Torque button head cap screw from 14 to 16 in-lb (1.6 to 1.8 N-m).

7. Place cradle sub-assembly (41) into housing (19) making sure dowel bushings (40) and cradle (41) are completely seated into housing. Retain cradle sub-assembly with two cap screws (42) after applying Loctite #277 (or equivalent) to the end of threads. Torque cap screws from 25 to 28 ft-lb (34 to 38 N-m).

8. Place exterior retaining ring (3), thrust race (12), thrust bearing (13), second thrust race (12), and second retaining ring (3) onto drive shaft (21). Position washer (24) and shaft seal (25) onto shaft.

9. Install shaft assembly into front of housing. Seat seal (25) into position with seal driver and retain with interior retaining ring (2).

10. Install servo piston follower (8) onto camplate dowel pin. Install camplate (11) carefully onto bushing (44) (coat bushing surface with hydraulic oil), aligning servo piston follower (8) with slot in servo piston assembly (7).

11. Position housing in a horizontal position. Holding camplate (11) in position with screw driver through controller linkage passageway at the top of housing, place rotating kit assembly (6) over shaft and into housing until pistons are against camplate (11). Make sure all parts are in housing completely and are properly positioned. Return the pump to the vise with open end of housing up, clamping housing on the outer portion of the flange.

12. Install gasket (32) onto housing.

13. If necessary, press new bearing (45) and roll pin (38) in backplate (20) to dimension shown in Figure 43. Note: Bearing should be installed with the numbered end outward. Roll pin should be installed with split oriented away from bearing.

14. Install new o-ring on relief valves (16 & 26). Install relief valve in the cavity in backplate that it was removed and torque from 100 to 110 ft-lb (136 to 149 N-m).

15. Install new o-ring on bypass valve (14). Install bypass valve (14) into backplate (20). Note: Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.

16. Apply a small amount of petroleum jelly to the steel side of valve plate (18) to hold in place for installation. Aligning the index pin, place the valve plate (18) in position onto the backplate (20), with steel side against backplate.

17. Install backplate assembly (20) onto housing assembly (19). Make sure ports are positioned correctly, and that valve plate (18) and gasket (32) stay in place.

18. Retain backplate (20) with four cap screws (15). Torque cap screws from 27 to 31 (37 to 42 N-m).

19. Install control housing gasket (34) onto housing. Install orifices (30) into servo control assembly (28) and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly (28) onto housing making sure feedback link entered small groove in servo piston assembly (7).

20. Secure control assembly with six socket head screws (17). Torque screws from 40 to 48 in-lb (4.5 to 5.4 N-m).

21. Install control arm (27) onto control assembly input shaft. Retain with lock washer (23) and nut (22). Torque nut from 4 to 6 ft-lb (5 to 8 N-m).

22. Install remaining plugs that were removed from pump. Torque 3/4 in. plug from 21 to 24 ft-lb (28 to 32 N-m). Torque 1-1/4 in. plug from 40 to 45 ft-lb (54 to 61 N-m).

Piston Pump Control Assembly

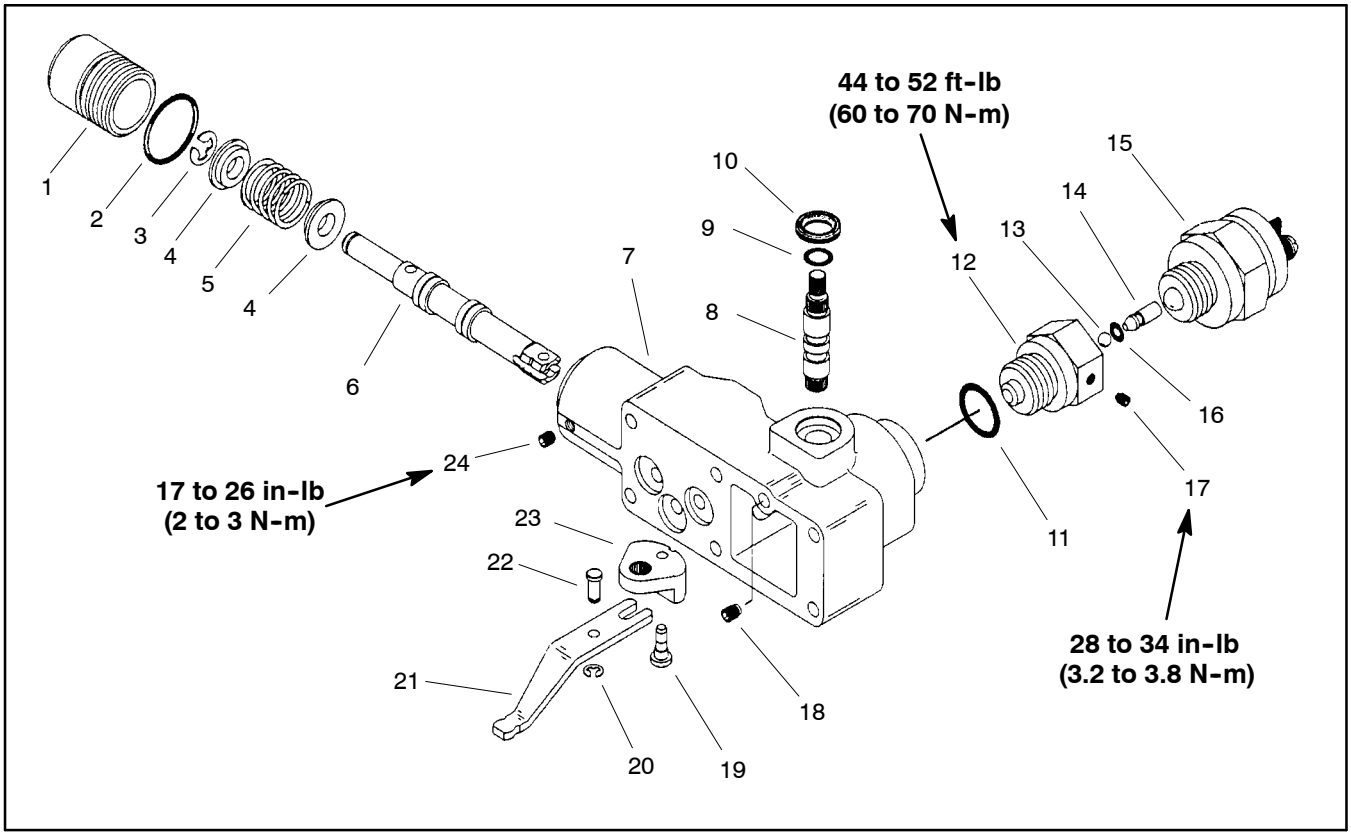

Figure 47

1. Plug
2. O-ring
3. Retaining ring
4. Spring retainer
5. Spring
6. Spool valve
7. Control housing
8. Input shaft
9. O-ring
10. Wiper seal
11. O-ring
12. Adaptor
13. Ball
14. Pin
15. Neutral switch
16. O-ring
17. Set screw
18. Set screw
19. Pin
20. Retaining ring
21. Feedback link
22. Dowel pin
23. Bell crank
24. Set screw

Disassembly - Manual Servo Control Assembly

1. Remove wiper seal with screw driver. Remove set screw (18) that retains input shaft and remove input shaft from control housing. Remove o-ring from shaft.

2. Remove set screw (24) from plug that retains valve spool. Remove plug from control housing and o-ring from plug.

3. Remove retaining ring (20) from pin that retains feedback link and spool valve. Remove pin, feedback link, spool valve, and bell crank from control housing.

4. Compress spring and remove retaining ring (3). Remove spring retainer, spring, and second spring retainer from spool valve.

5. Clean all parts and lubricate in clean hydraulic oil for reassembly.

Reassembly - Manual Servo Control Assembly

1. Install spring retainer, spring, and second spring retainer onto spool valve. Compress spring to allow retaining ring (3) to be installed onto spool valve.

2. Install spool valve into control housing making sure that metering notches on spool valve can be seen in the metering ports.

3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool, aligning holes, and install dowel pin and retaining ring (20).

4. Install new o-ring (9) onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.

5. Apply Loctite #242 or equivalent to set screw (18) and install into control housing. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.

6. Install wiper seal on input shaft.

7. Install new o-ring (2) onto plug and install plug. Adjust plug until there is no end play in the valve spool with input shaft held stationary. Secure plug in place with set screw (24). Torque set screw from 17 to 26 in-lb (2 to 3 N-m).

Disassembly - Neutral Switch

1. Loosen set screw (17) in adapter and remove neutral switch from adapter.

2. Remove adapter from control housing.

3. Remove pin, ball, and o-rings (11 & 16) from adapter.

Reassembly - Neutral Switch

1. Install new o-ring (11) onto adapter and new o-ring (16) onto pin.

2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.

3. Install adapter into control housing. Torque from 44 to 52 ft-lb (60 to 70 N-m).

4. Apply Loctite #222 or equivalent to threads of neutral switch and install switch into adapter. The adjustment procedure for the switch are as follows.

A. Install switch, while moving link back and forth, until “detent” action is detected. Back out the switch until the “detent” action is very slight.

B. Attach the leads from a test light to the switch terminals. **Note:** A multimeter could be used instead of a test light.

C. Move the link out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position “A” (Fig. 48). Move the link to the detent position and the test light should come back on.

D. Leaving the link in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position “B”.

E. Unscrew the switch one third of the distance between “B” and “A”. Install and tighten the set screw (17) in one of the upper quadrants of the hex of the switch adapter (Fig. 48). Torque set screw from 28 to 34 in-lb (3.2 to 3.8 N-m).

5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.

6. Remove test light and put servo control assembly into operation.

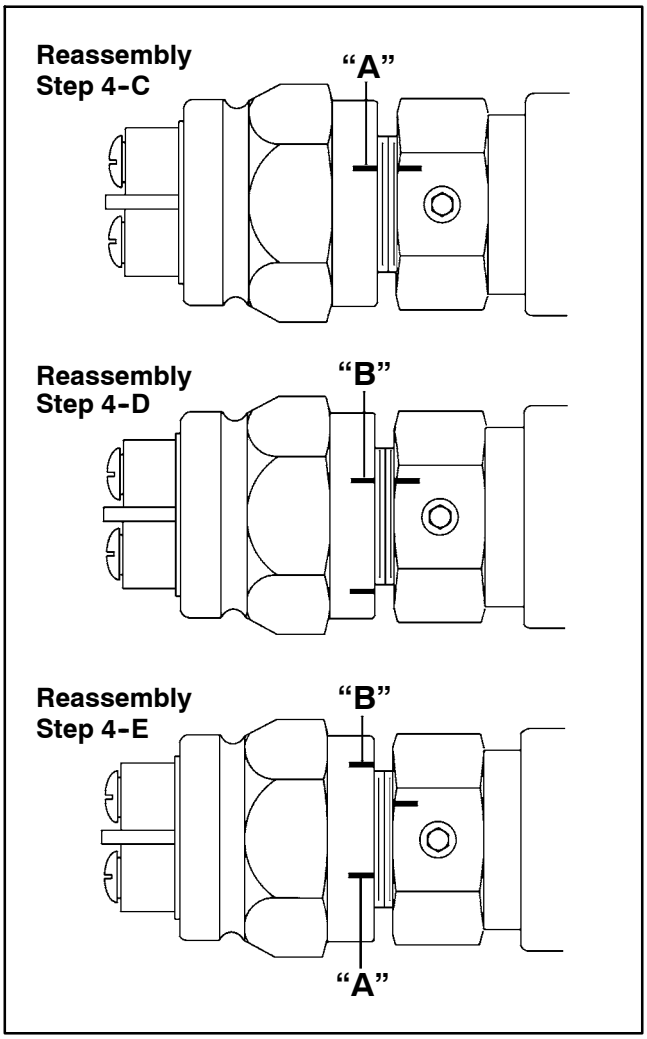

Figure 48

Hydraulic Control Manifold: 4 Wheel Drive

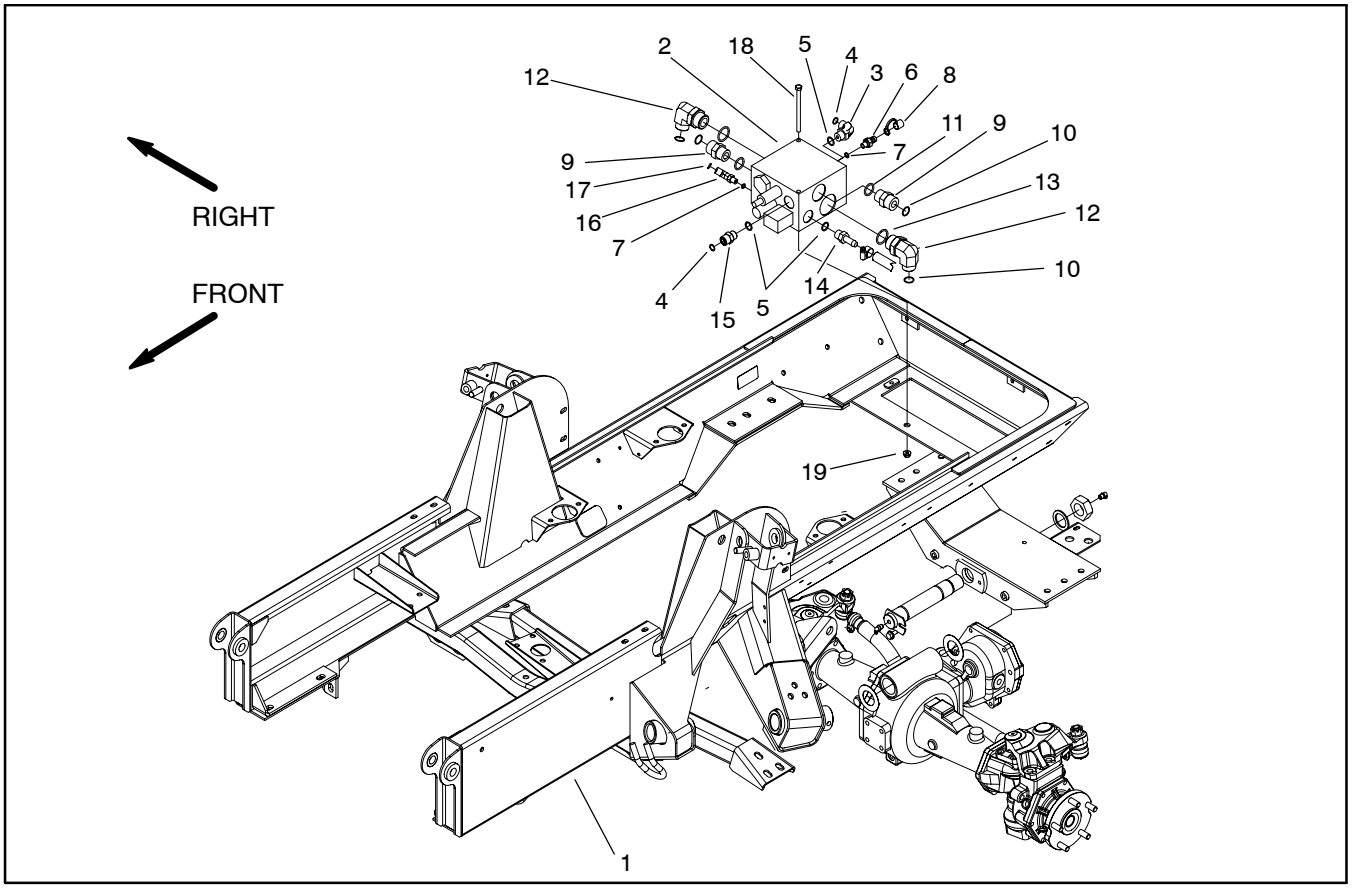

Figure 49

1. **Frame assembly**
2. **Manifold**
3. **90º hydraulic fitting**
4. **O-ring**
5. **O-ring**
6. **Quick fitting**
7. **O-ring**
8. **Fitting cap**
9. **Hydraulic fitting**
10. **O-ring**
11. **O-ring**
12. **90º hydraulic fitting**
13. **O-ring**
14. **Hydraulic fitting**
15. **Adapter**
16. **Hydraulic fitting**
17. **O-ring**
18. **Cap screw**
19. **Flange nut**

Removal

NOTE: The ports on the manifold are marked for easy identification of components. Example: P1 is a piston pump connection port and 2 is the location for the solenoid valve (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect electrical connector from the solenoid valve.

3. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

4. Remove hydraulic manifold from the frame using Figure 49 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 49 as guide.

2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.

3. Connect electrical connector to the solenoid valve.

Hydraulic Control Manifold Service: 4 Wheel Drive

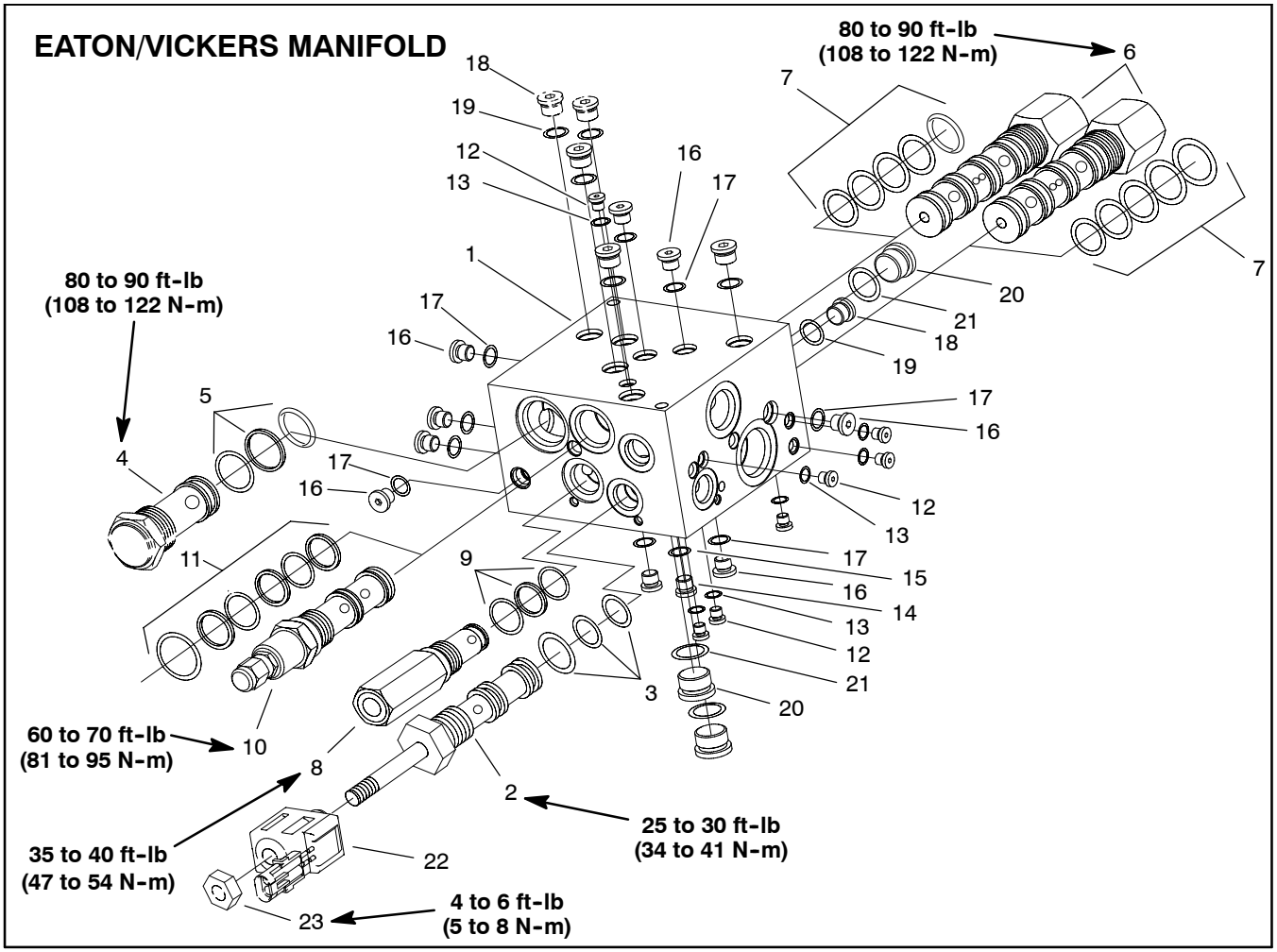

Figure 50

1. Manifold body
2. Solenoid valve (port 2)
3. Seal kit
4. Check valve (port 3)
5. Seal kit
6. Control valve (ports 5A & 5B)
7. Seal kit
8. Relief valve (port 7)
9. Seal kit
10. Reducing valve (port 8)
11. Seal kit
12. Plug (SAE #2)
13. O-ring
14. Plug (SAE #4)
15. O-ring
16. Plug (SAE #5)
17. O-ring
18. Plug (SAE #6)
19. O-ring
20. Plug (SAE #10)
21. O-ring
22. Solenoid coil
23. Nut

NOTE: The ports on the manifold are marked for easy identification of components. Example: P1 is a piston pump connection port and 2 is the location for the solenoid valve (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

NOTE: 4WD manifolds used on Groundsmaster 4000-D machines are either Eaton/Vickers (Fig. 50) or JEM (Fig. 51).

Valve Cartridge Service

1. Make sure the manifold is clean before removing the valve.

2. If cartridge is solenoid operated, remove nut securing solenoid to the cartridge valve. Carefully slide solenoid off the valve.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

3. Remove cartridge valve with a deep socket wrench. Note correct location for o-rings, sealing rings, and backup rings. Remove and discard seal kit.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads, and contamination.

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.

B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful not to damage cartridge. Use compressed air for cleaning.

7. Reinstall the cartridge valve:

A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The o−rings, sealing rings, and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

B. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.

C. Torque cartridge valve using a deep socket to value identified in manifold illustration.

D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Apply “Loctite 242” or equivalent to the threads of the valve. Torque nut to value identified in manifold illustration.

8. If problems still exist, remove valve and clean again or replace valve.

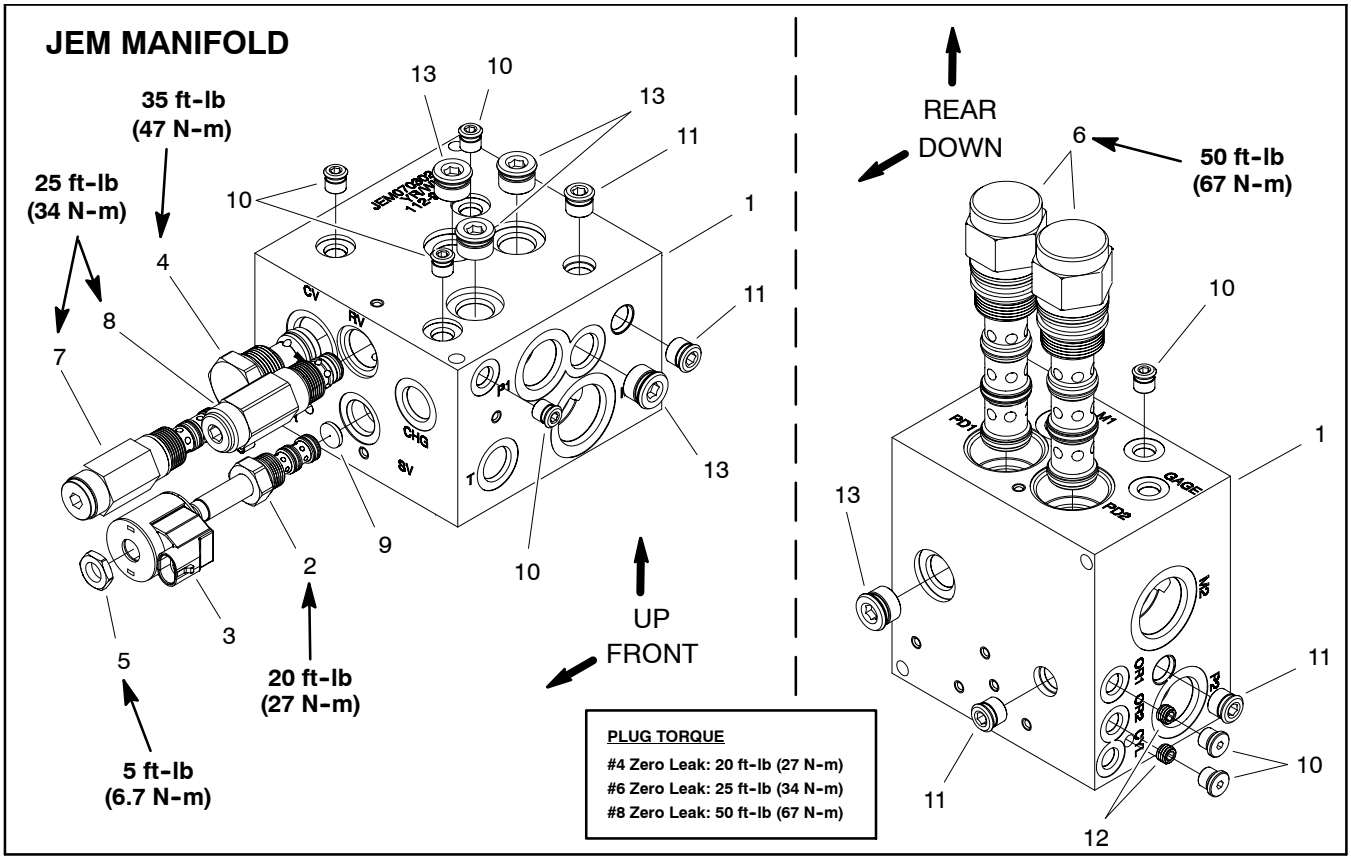

Figure 51

1. Manifold body
2. Solenoid valve (port SV)
3. Solenoid coil
4. Check valve (port CV)
5. Nut
6. Directional valve (ports PD1 & PD2)
7. Pressure reducing valve (port PR)
8. Relief valve (port RV)
9. Orifice (.030)
10. #4 zero leak plug with O-ring
11. #6 zero leak plug with O-ring
12. Orifice (.050)
13. #8 zero leak plug with O-ring

Hydraulic Control Manifold: Deck Drive

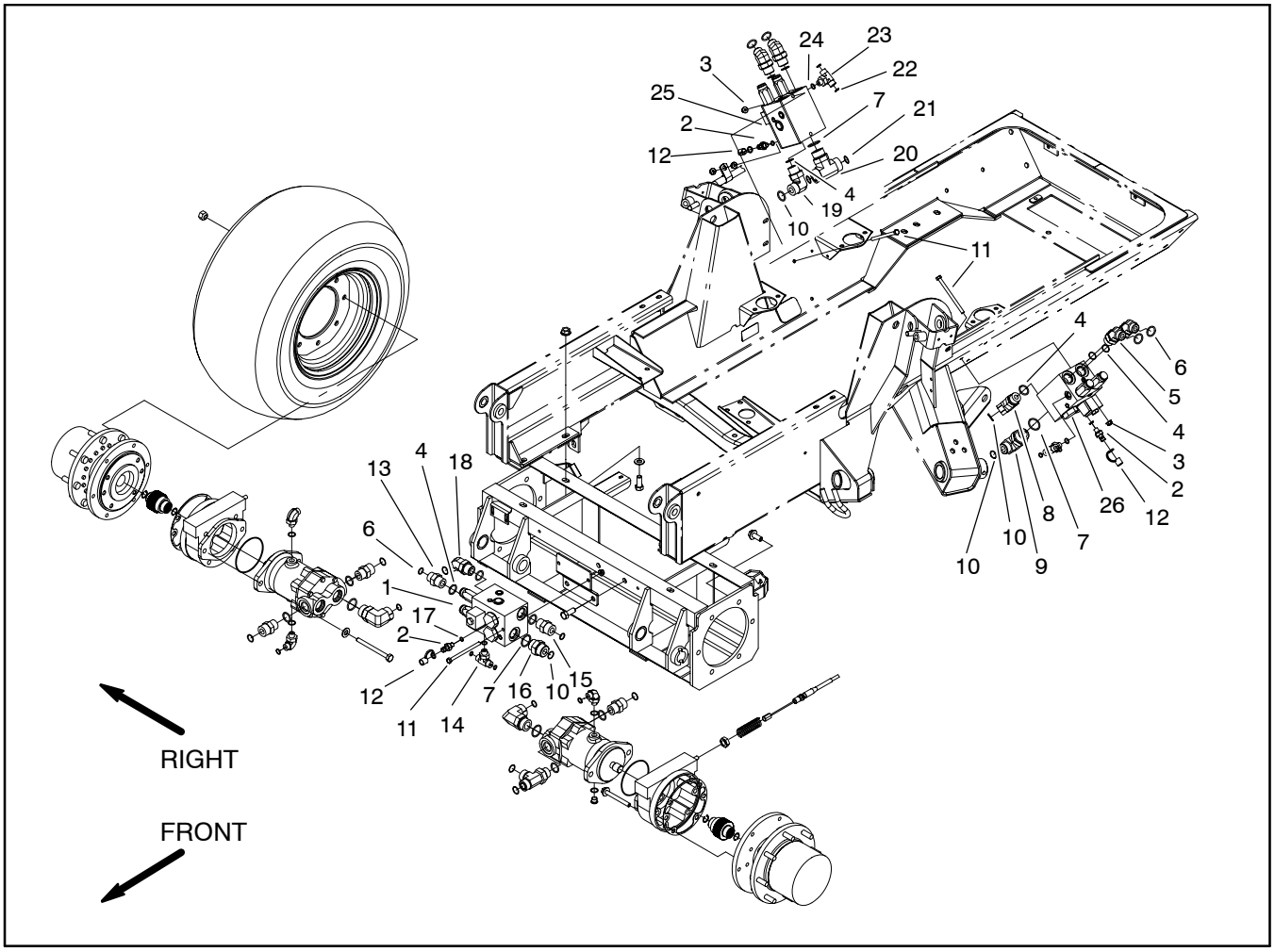

Figure 52

1. **Hydraulic manifold (front deck)**
2. **Quick fitting**
3. **Flange nut**
4. **O-ring**
5. **Hydraulic fitting**
6. **O-ring**
7. **O-ring**
8. **45º hydraulic fitting**
9. **Adapter**
10. **O-ring**
11. **Cap screw**
12. **Fitting cap**
13. **Adapter**
14. **Adapter**
15. **Straight hydraulic fitting**
16. **Adapter**
17. **O-ring**
18. **Hydraulic fitting**
19. **Elbow (90º)**
20. **Hydraulic fitting**
21. **O-ring**
22. **O-ring**
23. **Adapter**
24. **O-ring**
25. **Hydraulic manifold (RH deck)**
26. **Hydraulic manifold (LH deck)**

Removal

NOTE: The ports on the manifold are marked for easy identification of components. Example: SV1 is the deck solenoid valve and P1 is a gear pump connection port. (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect electrical connector from the solenoid valve.

3. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

4. Remove hydraulic manifold from the frame using Figure 52 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 52 as guide.

2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.

3. Connect electrical connector to the solenoid valve.

Hydraulic Control Manifold Service: Deck Drive

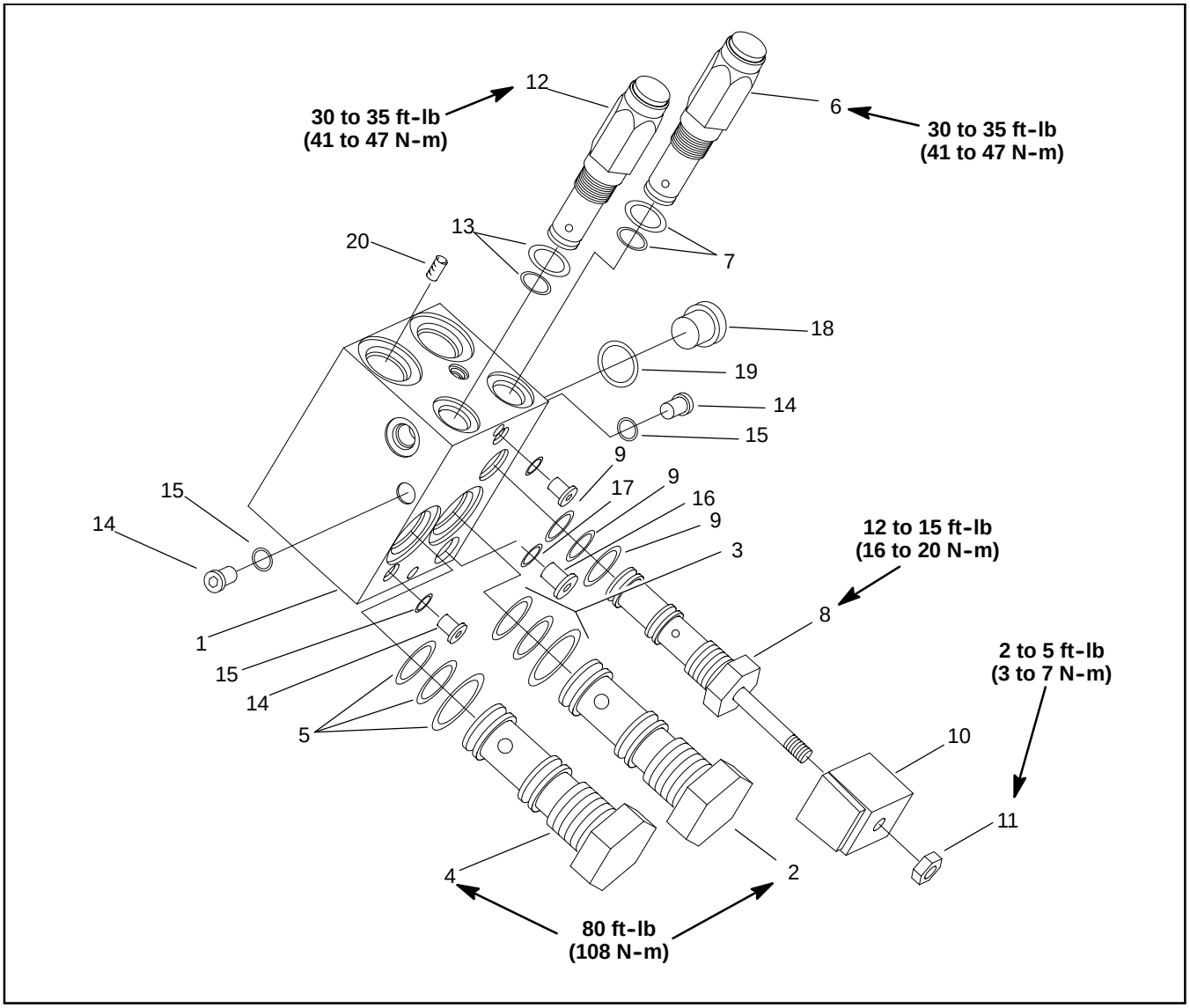

Figure 53

1. **Manifold body**
2. **Spool logic cartridge (port BY1)**
3. **Seal kit**
4. **Spool logic cartridge (port BR1)**
5. **Seal kit**
6. **Relief valve (port R1BY)**
7. **Seal kit**
8. **Solenoid valve (port SV1)**
9. **Seal kit**
10. **Solenoid coil**
11. **Nut**
12. **Relief pilot cartridge (port R1BR)**
13. **Seal kit**
14. **Plug (SAE #2)**
15. **O-ring**
16. **Plug (SAE #4)**
17. **O-ring**
18. **Plug (SAE #8)**
19. **O-ring**
20. **Orifice plug (port MR)**

NOTE: The ports on the manifold are marked for easy identification of components. Example: SV1 is the deck solenoid valve and P1 is the gear pump connection port. (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port location).

The control manifolds for the three cutting decks are very similar. **Note:** When servicing the deck control manifolds, **DO NOT** interchange parts from one control manifold to another.

For solenoid and control valve service procedures, see Hydraulic Control Manifold Service: 4 Wheel Drive in this section. Refer to Figure 53 for cartridge valve installation torque.

Hydraulic Control Manifold: Cutting Deck Lift/Lower

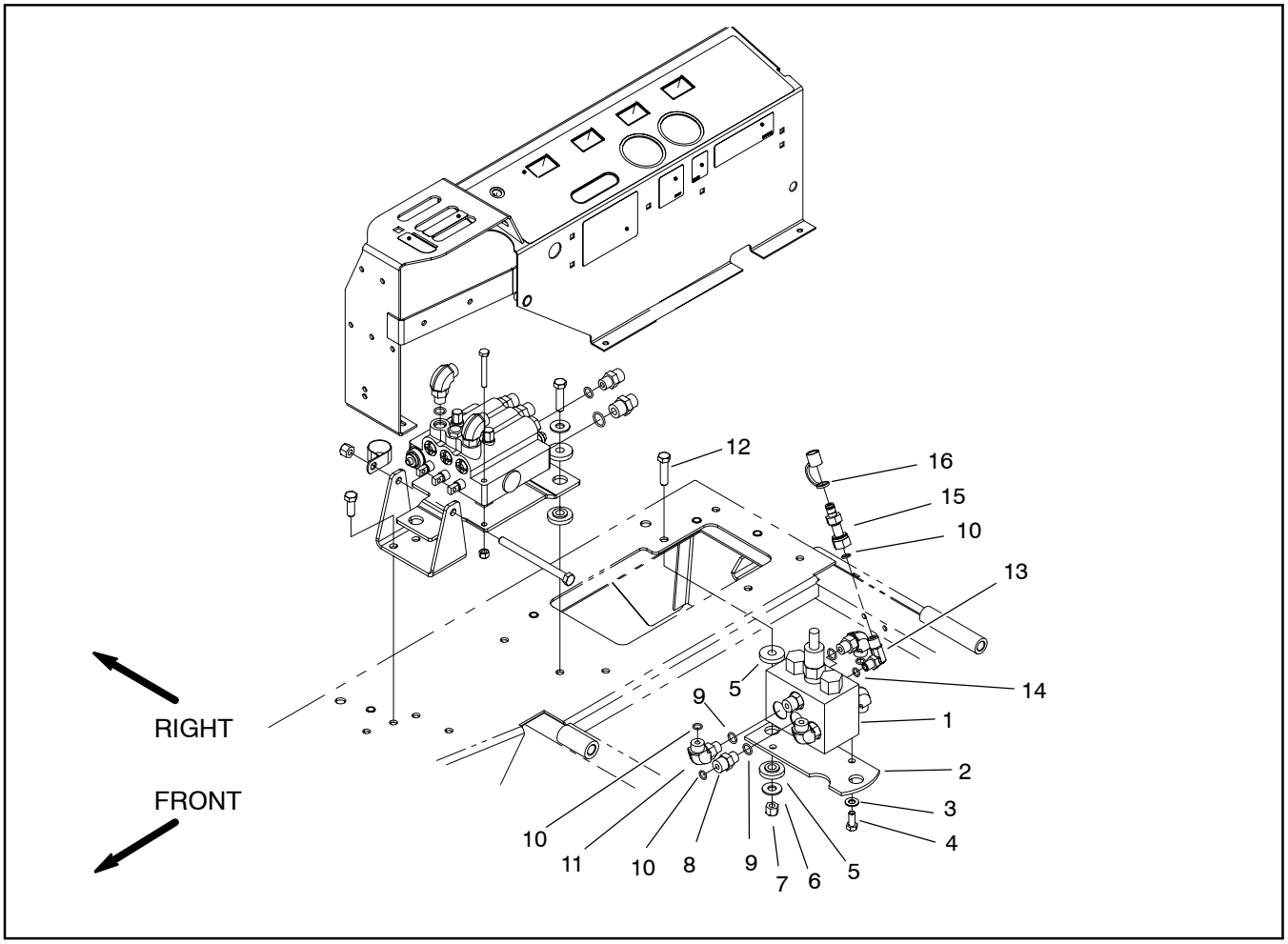

Figure 54

1. **Lift/lower hydraulic manifold**
2. **Valve plate**
3. **Flat washer**
4. **Cap screw**
5. **Grommet**
6. **Flat washer**
7. **Lock nut**
8. **Hydraulic fitting**
9. **O-ring**
10. **O-ring**
11. **90º hydraulic fitting**
12. **Cap screw**
13. **90º hydraulic fitting**
14. **O-ring**
15. **Test nipple**
16. **Fitting cap**

Removal

NOTE: The ports on the manifold are marked for easy identification of components. Example: C1 is the connection port from the LH deck lift cylinder and CHG is the charge circuit connection (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

3. Remove hydraulic manifold from the frame using Figure 54 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 54 as guide.

2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.

Hydraulic Control Manifold Service: Cutting Deck Lift/Lower

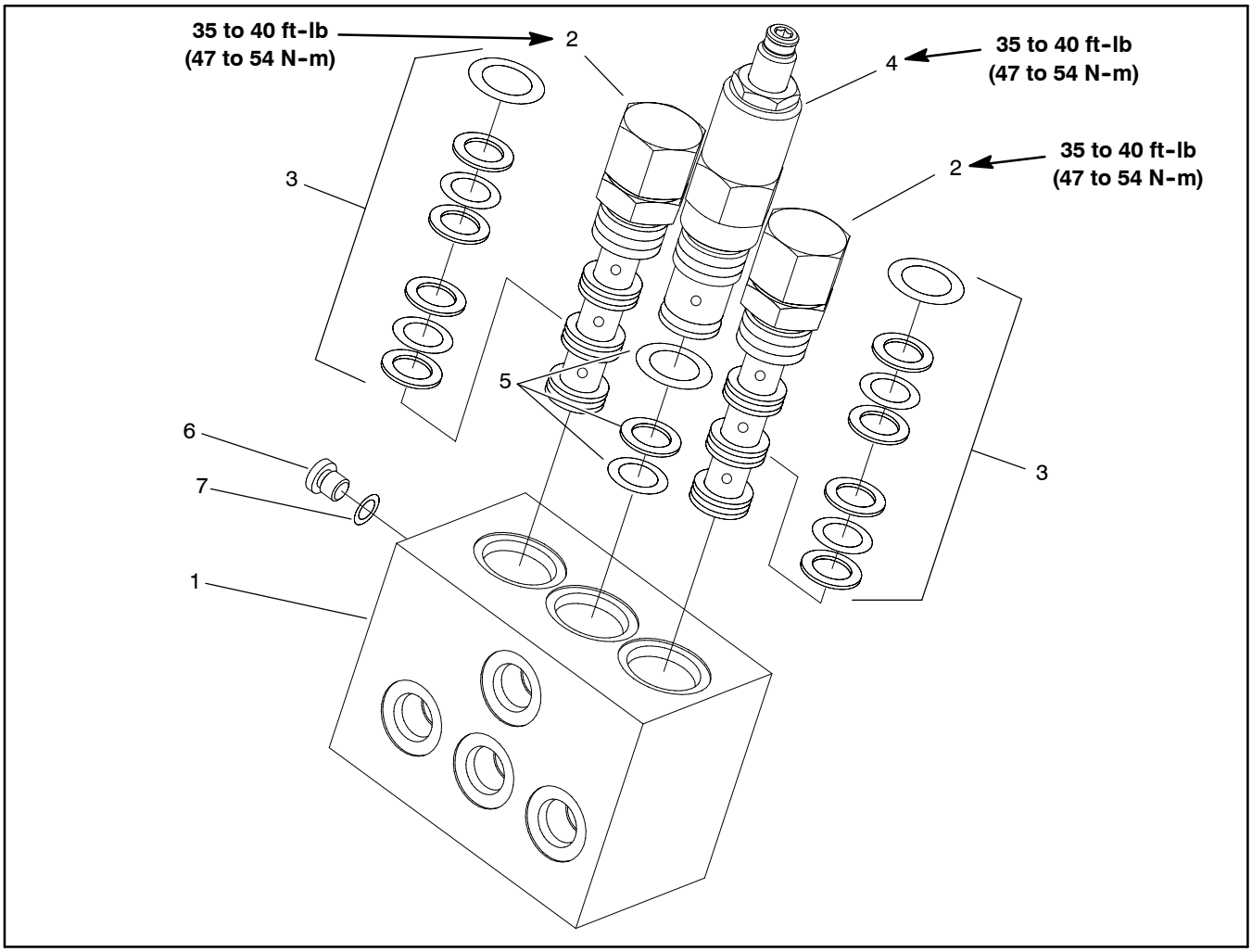

Figure 55

1. **Manifold body**
2. **Pilot valve**
3. **Seal kit**
4. **Relief valve (Counterbalance)**
5. **Seal kit**
6. **Plug (SAE #2)**
7. **O-ring**

NOTE: The ports on the manifold are marked for easy identification of components. Example: C1 is the connection port from the LH deck lift cylinder and CHG is the charge circuit connection (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

For cartridge valve service procedures, see Hydraulic Control Manifold Service: 4 Wheel Drive in this section. Refer to Figure 55 for cartridge valve installation torque.

Hydraulic Manifold: Filter Manifold

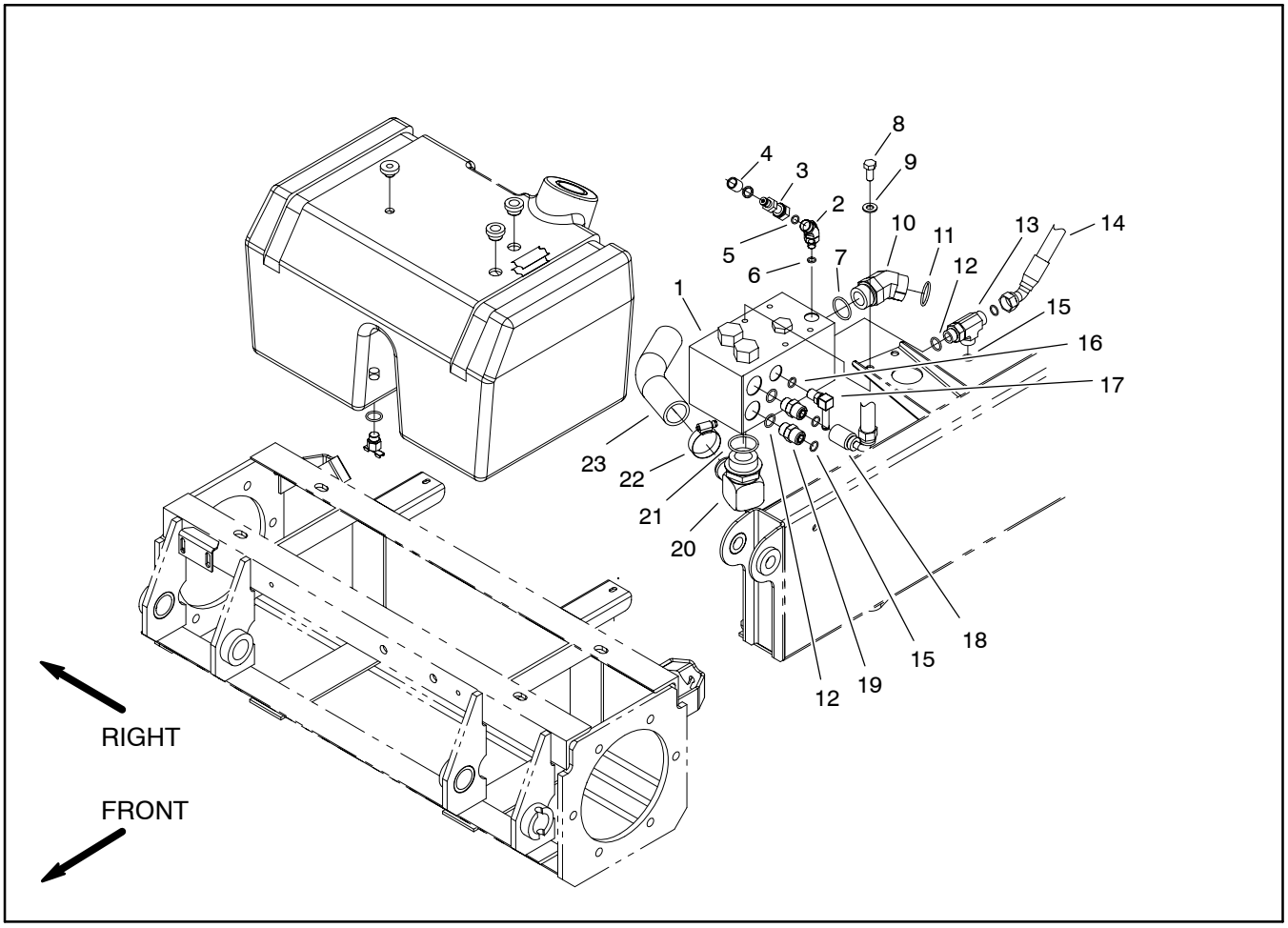

Figure 56

1. **Filter manifold**
2. **45º hydraulic elbow**
3. **Test nipple**
4. **Fitting cap**
5. **O-ring**
6. **O-ring**
7. **O-ring**
8. **Cap screw**
9. **Flat washer**
10. **Hydraulic fitting**
11. **O-ring**
12. **O-ring**
13. **Hydraulic fitting**
14. **Hydraulic hose**
15. **O-ring**
16. **O-ring**
17. **90º hydraulic elbow**
18. **Hydraulic hose**
19. **Hydraulic fitting**
20. **90º hydraulic fitting**
21. **O-ring**
22. **Hose clamp**
23. **Filter hose**

Removal

NOTE: The ports on the manifold are marked for easy identification of components. Example: P2 is the gear pump connection port and CD is the connection for the case drain from the deck motors (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

3. Remove hydraulic manifold from the frame using Figure 56 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 56 as guide.

2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.

Hydraulic Manifold Service: Filter Manifold

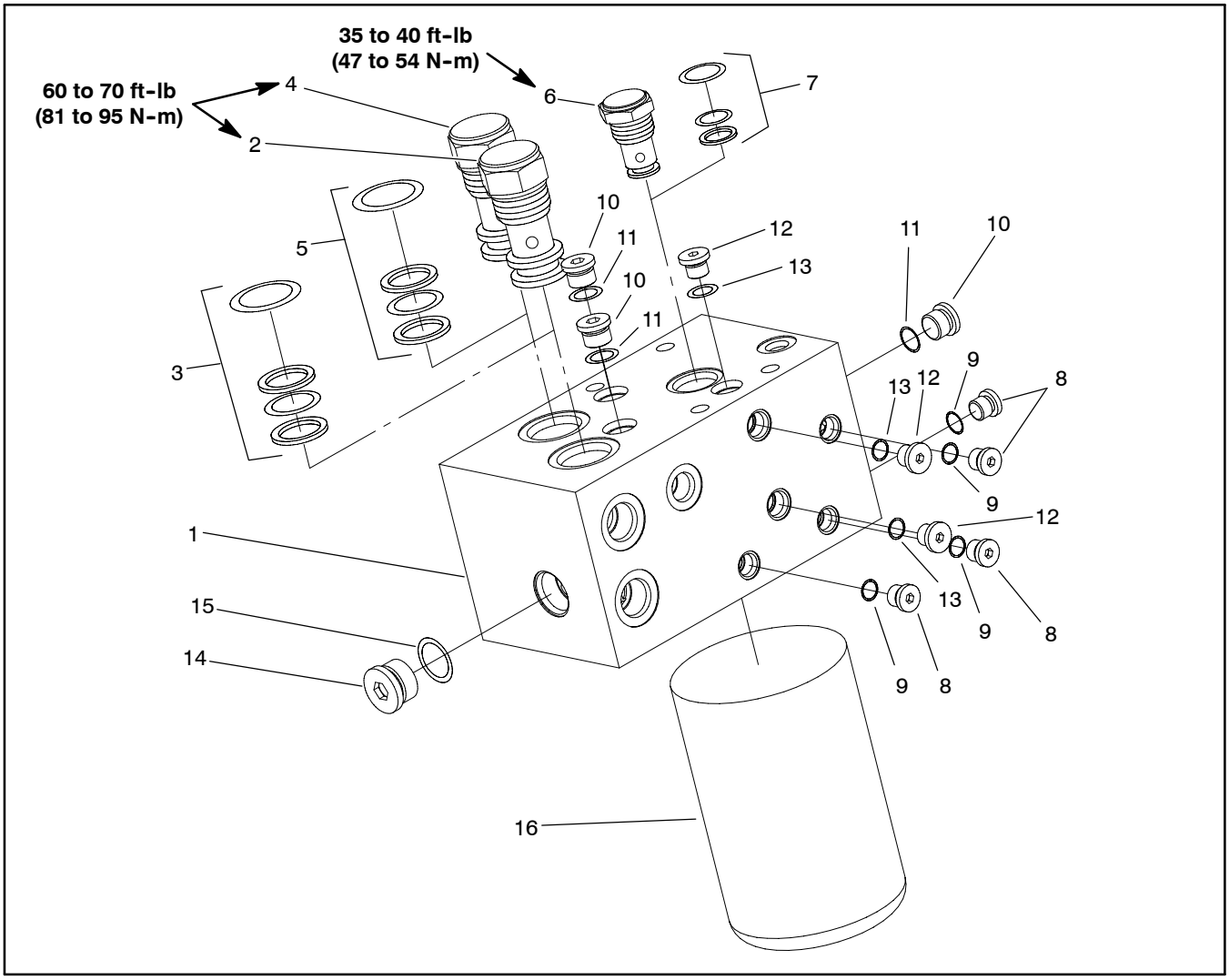

Figure 57

1. **Filter manifold assembly**
2. **Check valve (Reservoir return)**
3. **Seal kit**
4. **Check valve (Filter bypass)**
5. **Seal kit**
6. **Check valve (Charge pressure)**
7. **Seal kit**
8. **Plug (SAE #4)**
9. **O-ring**
10. **Plug (SAE #6)**
11. **O-ring**
12. **Plug (SAE #5)**
13. **O-ring**
14. **Plug (SAE #10)**
15. **O-ring**
16. **Oil filter element**

NOTE: The ports on the manifold are marked for easy identification of components. Example: P2 is the gear pump connection port and CD is the connection for the case drain from the deck motors (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

For cartridge valve service procedures, see Hydraulic Control Manifold Service: 4 Wheel Drive in this section. Refer to Figure 57 for cartridge valve installation torque.

Hydraulic Manifold: Flow Divider

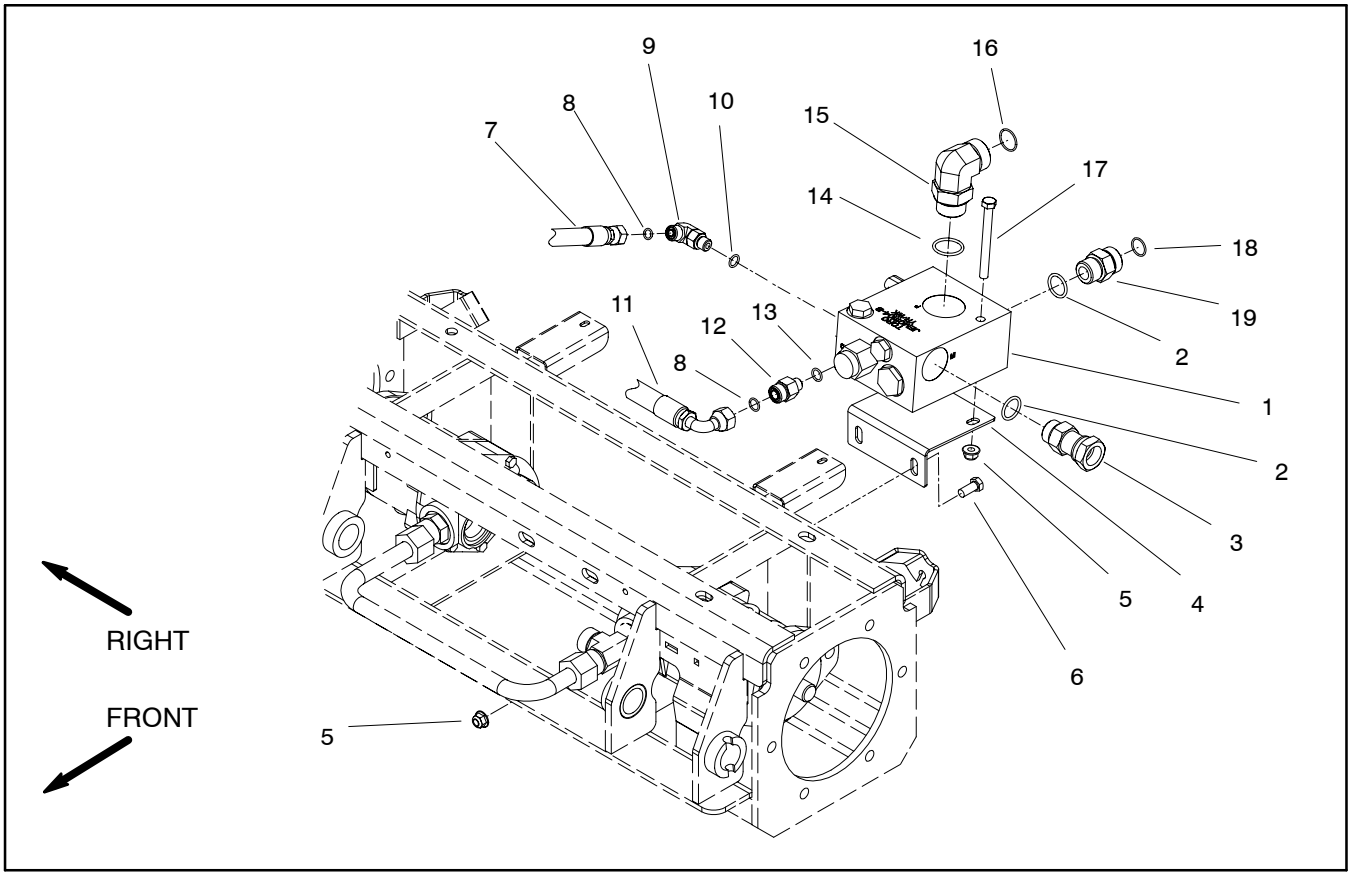

Figure 58

1. **Hydraulic manifold**
2. **O-ring**
3. **Hydraulic fitting**
4. **Bracket**
5. **Flange nut**
6. **Cap screw (2 used)**
7. **Hydraulic hose**
8. **O-ring**
9. **90º hydraulic elbow**
10. **O-ring**
11. **Hydraulic hose**
12. **Hydraulic fitting**
13. **O-ring**
14. **O-ring**
15. **90º hydraulic elbow**
16. **O-ring**
17. **Cap screw**
18. **O-ring**
19. **Hydraulic fitting**

NOTE: The hydraulic Flow Divider is included as a hydraulic system component on machines with serial numbers above 230000000. The Flow Divider was an optional kit for earlier production machines (serial numbers below 220999999).

Removal

NOTE: The ports on the manifold are marked for easy identification of hydraulic line connections. Example: P is the traction pump connection port and M1 is the connection for the front traction motors (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

3. Remove hydraulic manifold from the frame using Figure 58 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 58 as guide.

2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.

Hydraulic Manifold Service: Flow Divider

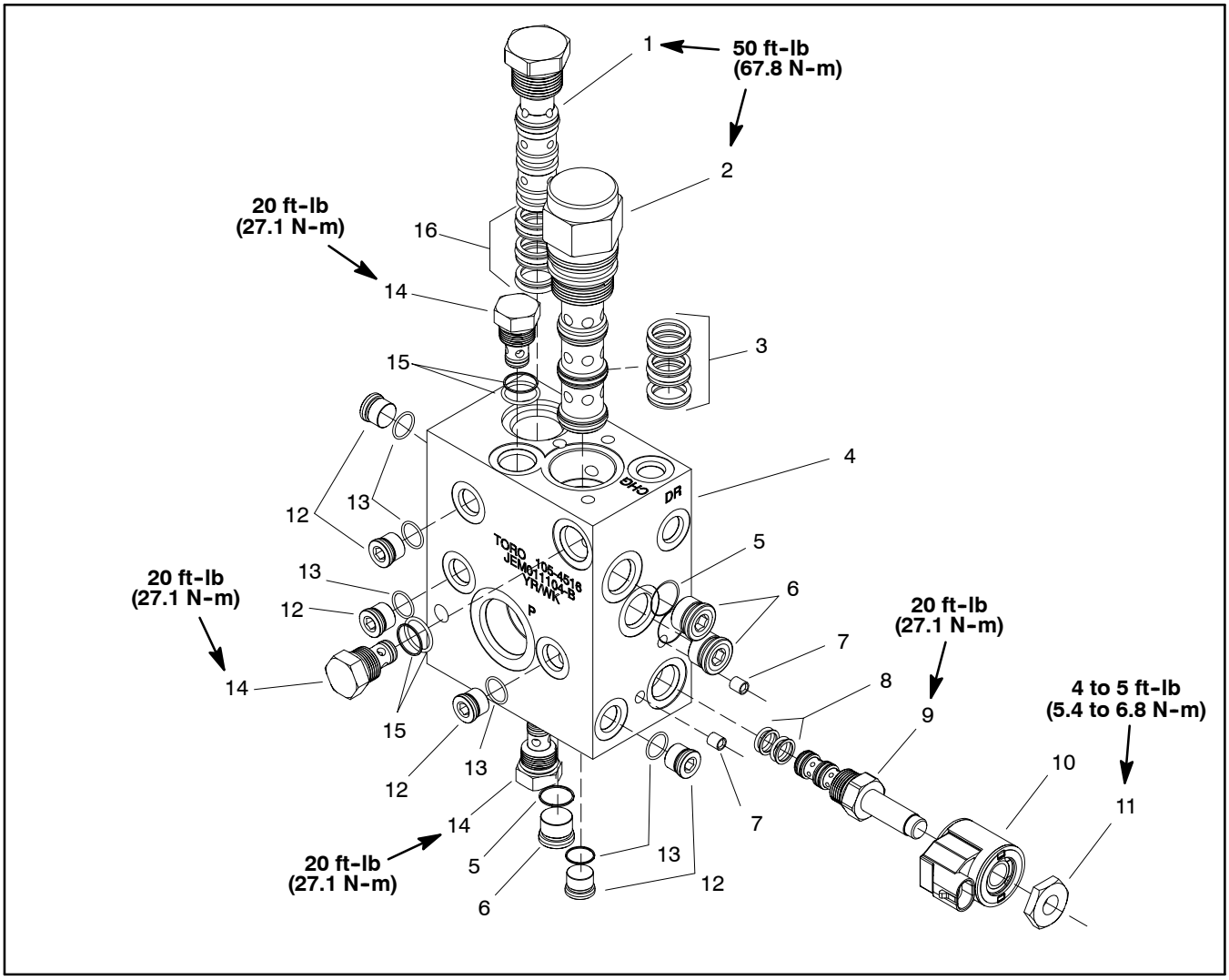

Figure 59

1. **Flow divider valve**
2. **Piloted directional valve**
3. **Seal kit**
4. **Hydraulic manifold**
5. **O-ring**
6. **Plug (SAE #8)**
7. **Plug (not serviced)**
8. **Seal kit**
9. **Solenoid cartridge valve**
10. **Solenoid coil**
11. **Nut**
12. **Plug (SAE #6)**
13. **O-ring**
14. **Check valve**
15. **Seal kit**
16. **Seal kit**

NOTE: The ports on the manifold are marked for easy identification of components. Example: P2 is the gear pump connection port and CD is the connection for the case drain from the deck motors (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

For cartridge valve service procedures, see Hydraulic Control Manifold Service: 4 Wheel Drive in this section. Refer to Figure 59 for cartridge valve installation torque.

Rear Axle Motor

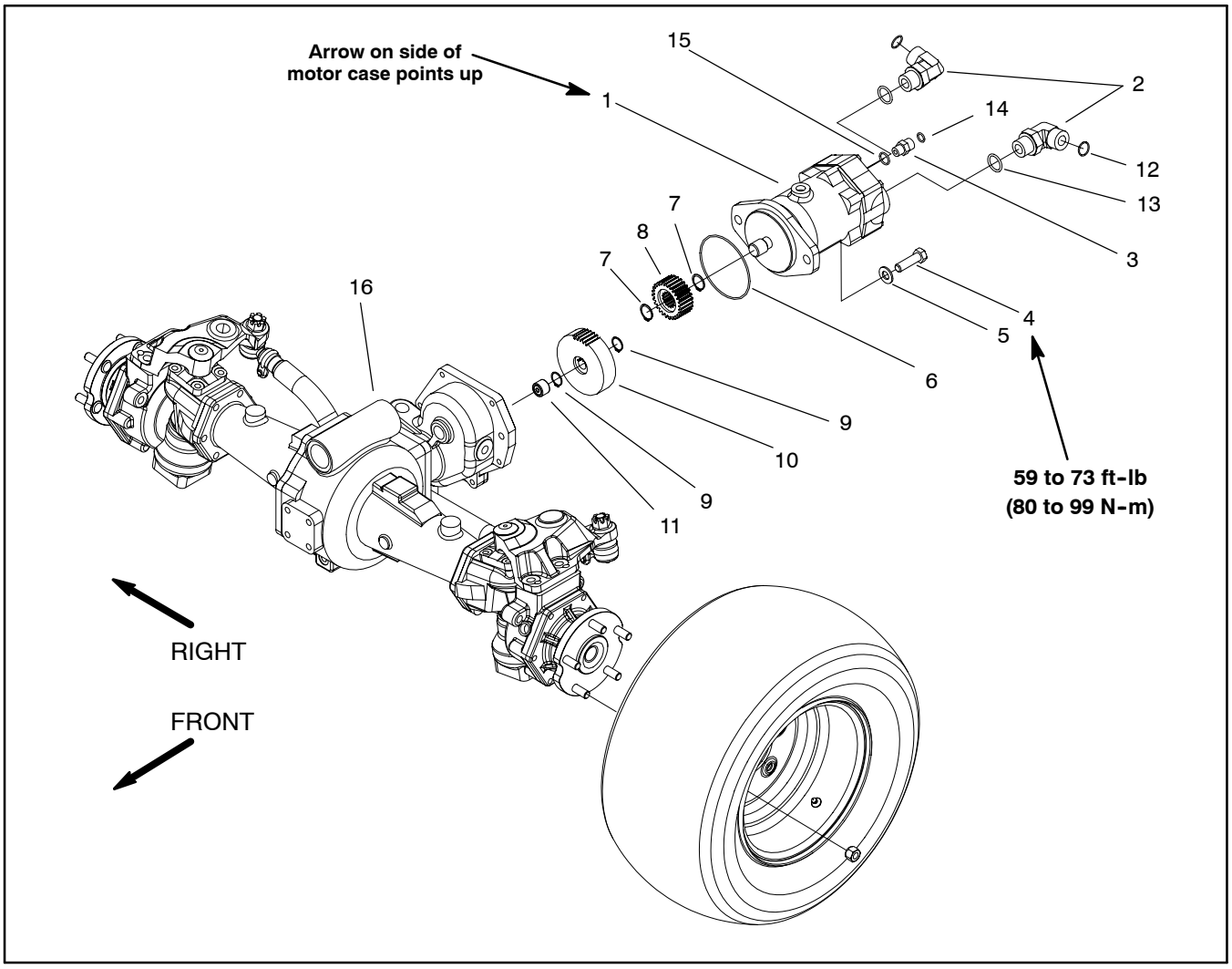

Figure 60

1. **Wheel motor**
2. **90º hydraulic fitting**
3. **Hydraulic fitting**
4. **Cap screw**
5. **Flat washer**
6. **O-ring**
7. **External snap ring**
8. **Pinion gear**
9. **External snap ring**
10. **Gear**
11. **Needle bearing**
12. **O-ring**
13. **O-ring**
14. **O-ring**
15. **O-ring**
16. **Drive axle assembly**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the axle motor.

3. Disconnect hydraulic hoses from motor. Put caps or plugs on ports to prevent contamination.

IMPORTANT: Support axle motor to prevent motor from falling during removal.

4. Remove motor using Figure 60 as a guide.

Installation

1. If removed, install pinion gear to axle motor.

2. Install o−ring onto motor. Position motor to rear axle assembly making sure that arrows on the side of motor case point upward. Align gear teeth and slide motor into place.

3. Secure motor to axle with cap screws and flat washers. Torque screws from 59 to 73 ft−lb (80 to 99 N−m).

4. Remove plugs from ports. Attach hydraulic hoses to axle motor.

5. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

6. After assembly is completed, verify that hydraulic hoses and fittings do not contact anything.

Front Wheel Motors

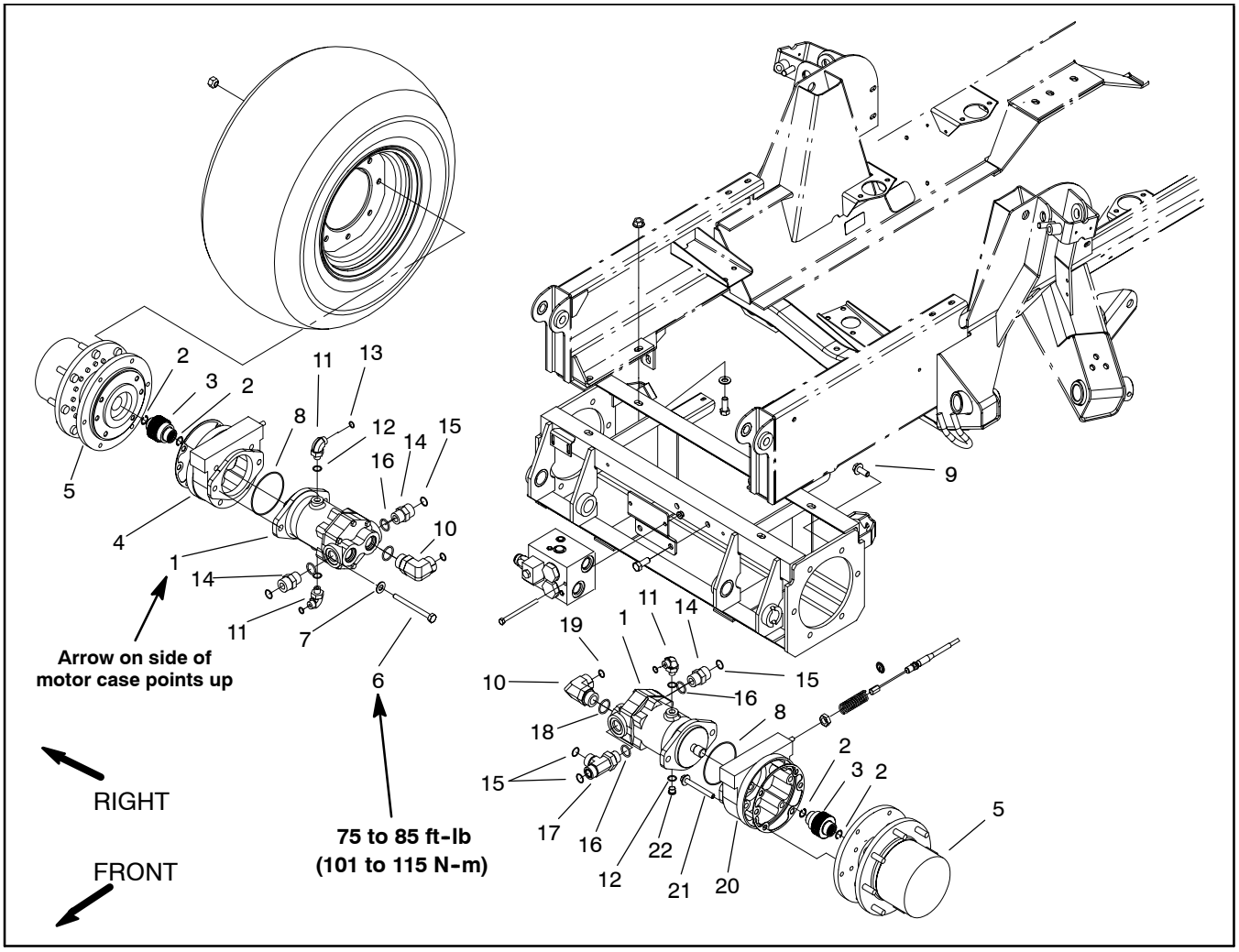

Figure 61

1. Front wheel motor
2. Internal retaining ring
3. Splined brake shaft
4. RH brake assembly
5. Planetary assembly
6. Cap screw
7. Flat washer
8. O-ring
9. Flange head screw
10. 90º hydraulic fitting
11. 90º hydraulic fitting
12. O-ring
13. O-ring
14. Hydraulic fitting
15. O-ring
16. O-ring
17. Hydraulic fitting
18. O-ring
19. O-ring
20. LH brake assembly
21. Flange head screw
22. Hex plug

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the wheel motor.

3. Disconnect hydraulic hoses and tubes from wheel motor. Put caps or plugs on ports to prevent contamination.

IMPORTANT: Before loosening fasteners, support wheel motor to prevent motor from falling during removal.

4. Remove wheel motor using Figure 61 as a guide.

Installation

1. Position wheel motor to brake assembly making sure that arrows on the side of motor case point upward.

2. Align splines on motor shaft and splined brake shaft. Slide motor into brake assembly.

3. Secure motor to brake assembly with cap screws and flat washers. Tighten cap screws from 75 to 85 ft-lb (101 to 115 N-m).

4. Remove plugs from ports. Attach hydraulic hoses and tubes to wheel motor.

5. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

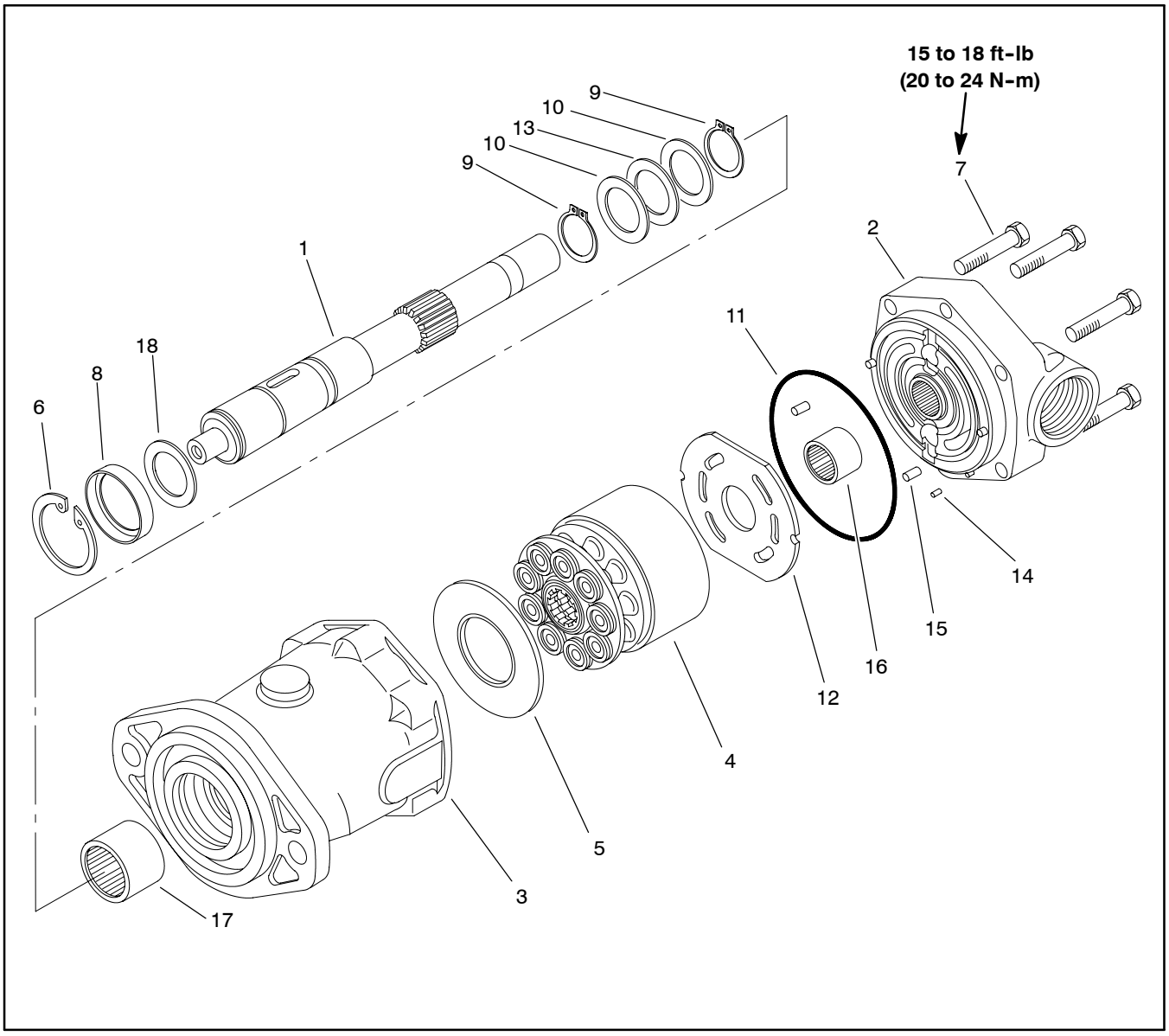

Figure 62

1. Drive shaft
2. Backplate (front motor shown)
3. Housing assembly
4. Rotating assembly
5. Cam plate insert
6. Retaining ring
7. Cap screw
8. Shaft seal
9. Retaining ring
10. Thrust race
11. O-ring
12. Valve plate
13. Thrust bearing
14. Roll pin
15. Roll pin
16. Bearing
17. Bearing
18. Washer

NOTE: The front wheel motors are identical. The rear axle motor has some differences from the front motors. Service of the front and rear motors requires the same procedures.

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting the lines, clean port area of motor. Thoroughly clean the outside of the motor. After cleaning, remove port plugs and drain oil.

Disassembly

1. Clamp the drive shaft end of the piston motor in a protected jaw vise with the cap screws up. Remove the six cap screws (7) from the motor assembly.

2. Use a soft face hammer and tap the backplate (2) to loosen and remove from housing.

3. Remove valve plate (12) and O-ring (11) from backplate. It is not necessary to remove roll pins (14, 15) in backplate.

4. Remove motor from vise and remove rotating assembly (4) from motor housing.

5. Remove the camplate insert (5) from housing. Use caution not to mar the finish that makes contact with pistons.

6. Remove retaining ring (6) from housing. Press shaft from housing and remove shaft seal (8) and washer (18).

7. Remove retaining rings (9) from shaft and remove thrust races (10) and thrust bearing (13).

8. Discard the shaft seal and o-ring, and replace with new items upon reassembly.

Inspection

1. Check the condition of the needle bearing (16) in backplate (2) and replace if necessary.

2. Inspect valve plate (12) on the bronze side next to the piston block for wear. A smooth surface is required. **Do not lap valve plate bronze surface.** Replace valve plate if any wear exists.

3. Inspect the piston block surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. **Do not lap piston block.**

4. The pistons should move freely in the piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.

5. Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**

6. Examine the spider for wear in the pivot area.

7. Examine the spider pivot to insure smoothness and no signs of wear.

8. The polished finish on the shoe surface of the camplate insert (5) should show no signs of scoring.

9. Inspect the shaft for wear in the seal, bearing and spline areas.

10. Inspect thrust bearing (13) and races (10) for wear.

11. Check the condition of the needle bearing (17) in housing and replace if necessary.

Reassembly

1. Clean all parts in suitable solvent and lubricate all internal parts with clean hydraulic oil before reassembly.

2. If necessary, install new needle bearing (17) in housing (3) with numbered end of the bearing outward.

3. Install retaining ring (9) on shaft. Install thrust race (10), thrust bearing (13), and second thrust race (10). Secure with second retaining ring (9).

4. Install shaft in housing. Install washer (18), new shaft seal (8), and retaining ring (6).

5. Install camplate insert (5) with the lettering side of insert to the front of the housing. Use petroleum jelly to hold in place during assembly.

6. Install rotating assembly (4) into housing. Make sure that piston shoes make contact with the camplate insert.

7. Clamp motor assembly in a protected jaw vise with the open end of the housing up.

8. If roll pins were removed, install to dimension shown in Figure 63 and with opening of roll pin oriented away from bearing within 5 degrees of bearing center line.

9. To replace bearing (16) in backplate (2). Press bearing down to the dimension shown (Fig. 63) protruding from backplate with numbered end of bearing facing up next to valve plate.

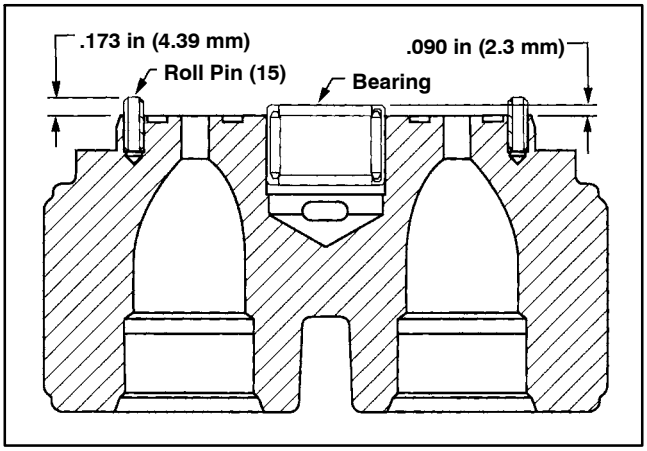

Figure 63

10. Apply small amount of petroleum jelly to the steel side of valve plate (12) to hold in place for installation. Place the valve plate in position onto the backplate (2), with steel side against backplate, bronze colored side against piston block.

11. Placing new o-ring (11) onto backplate, install backplate assembly (2) onto housing assembly. Make sure valve plate stays in position.

12. Insert cap screws and torque from 15 to 18 ft-lb (20 to 24 N-m) in a criss-cross pattern.

13. Fill case half full of new hydraulic oil.

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Cutting Deck Motor

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. Disconnect hydraulic lines from deck motor. Put caps or plugs on fittings and hoses to prevent contamination. Tag hydraulic lines for proper reassembly.

4. Remove two flange head screws that secure hydraulic motor to motor mount (Fig. 64).

5. Carefully remove hydraulic motor from cutting deck taking care not to damage spider hub attached to motor. Locate and remove spider and mounting shim(s) (if present) from the deck.

Installation

1. Check for proper clearance between spider hub and spindle pulley. Install motor to cutting deck without placing the spider in the spindle pulley. The clearance between hub and pulley valleys should be from .830" to .930" (21.1 to 23.6 mm). If required, use mounting shims between motor and motor mount to adjust clearance.

2. Position spider in spindle pulley. Place mounting shim(s) (if required) on deck. Carefully install hydraulic motor to the cutting unit taking care not to damage spider hub attached to motor.

3. Secure motor to cutting deck with two flange head screws (Fig. 64).

4. Remove caps or plugs from fittings and hoses. Connect hydraulic hoses to deck motor.

5. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by moving components.

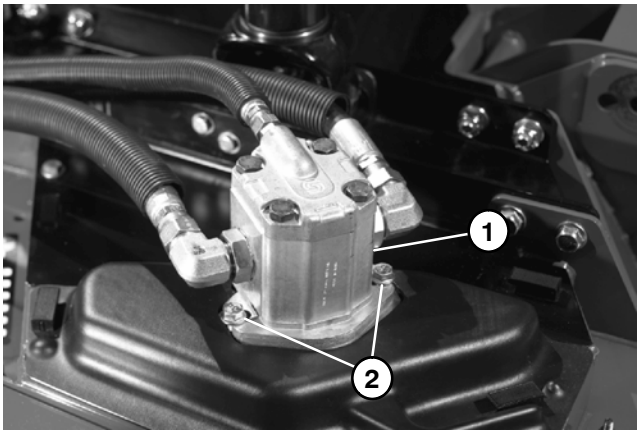

Figure 64

1. **Cutting deck motor**
2. **Flange head screw**

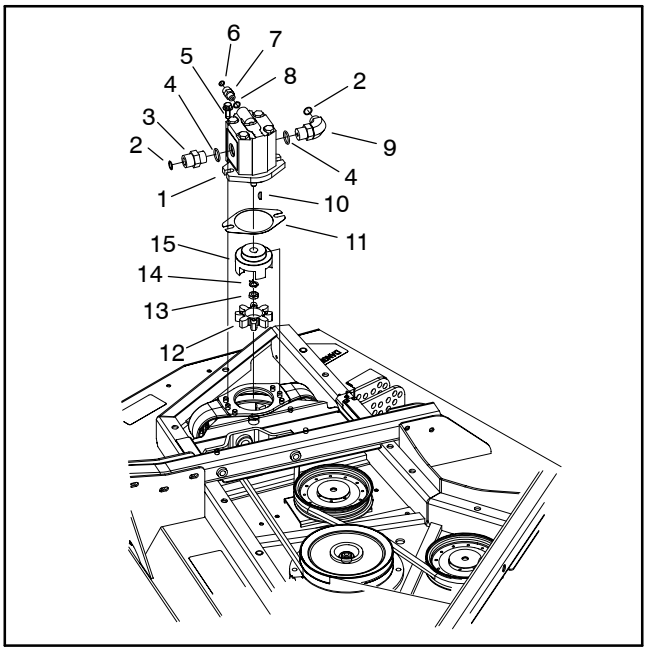

Figure 65

1. **Cutting deck motor**
2. **O-ring**
3. **Hydraulic adapter**
4. **O-ring**
5. **Flange head screw**
6. **O-ring**
7. **Hydraulic adapter**
8. **O-ring**
9. **90º hydraulic fitting**
10. **Woodruff key**
11. **Shim (if required)**
12. **Spider**
13. **Nut**
14. **Tab washer**
15. **Spider hub**

Cutting Deck Motor Service

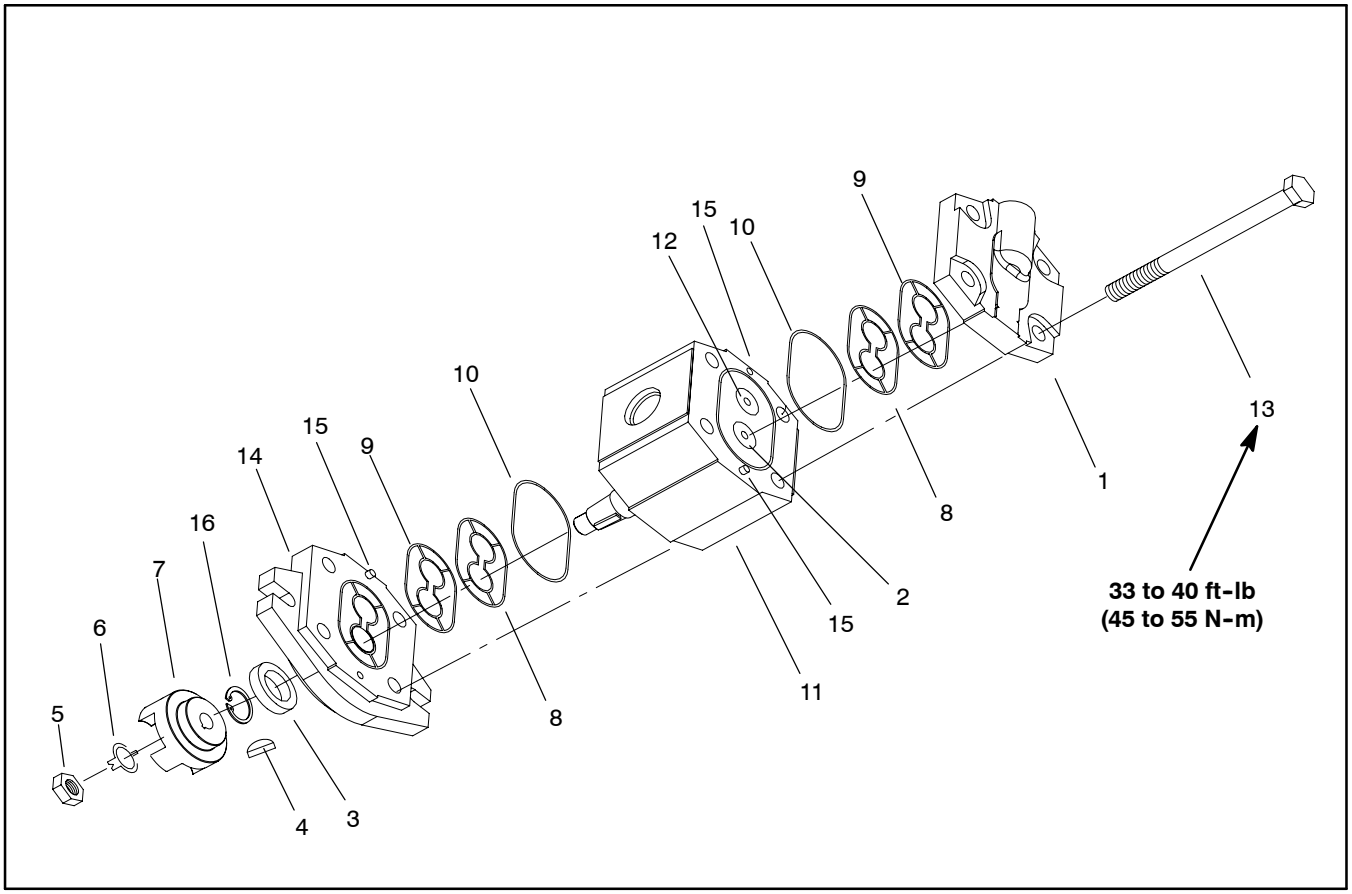

Figure 66

1. **Rear cover**
2. **Drive gear**
3. **Seal**
4. **Woodruff key**
5. **Nut**
6. **Tab washer**
7. **Spider hub**
8. **Pressure seal**
9. **Back-up ring**
10. **O-ring**
11. **Body**
12. **Idler gear**
13. **Cap screw**
14. **Front flange**
15. **Dowel pin**
16. **Snap ring**

Disassembly

1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.

2. Use a marker or scribe to make a **diagonal** mark across the front flange, body, and rear cover for reassembly purposes (Fig. 67).

IMPORTANT: Avoid using excessive clamping pressure on the motor flange to prevent distorting the casting.

3. Clamp mounting flange of motor in a vise with the shaft end down.

4. Loosen cap screws on the rear cover.

5. Take motor from the vise and remove cap screws.

6. Remove front flange from the body, then remove rear cover. Locate and remove dowel pins from body.

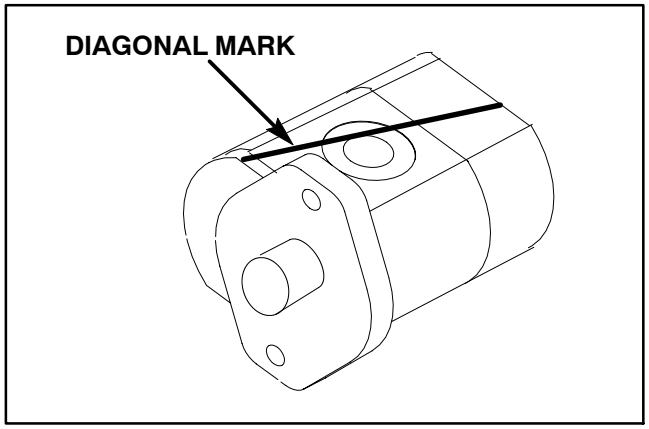

Figure 67

IMPORTANT: Mark the relative positions of the gear teeth and the bearing blocks so they can be re-assembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Place the motor on its side and push on the rear bearing block to remove the bearing block and gear set (Fig. 68).

8. Carefully remove and discard o−rings, pressure seals, and back−up rings (Fig. 69) from motor. Do not cause any damage to the machined grooves during the removal process.

IMPORTANT: Make sure not to damage the counter bore when removing the shaft seal from the front plate.

9. Position front flange with seal side up. Remove snap ring and shaft seal.

Inspection

1. Remove any nicks and burrs from all motor components with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all motor components with solvent. Dry all parts with compressed air.

3. Inspect drive gear, idler gear and bearing blocks (Fig. 70) for the following:

A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces, or wear on gear shafts indicates need for replacement.

B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.

C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into bearing blocks and, thus, must be replaced.

D. Bearing areas of bearing blocks should not have excessive wear or scoring.

E. Face of bearing blocks that are in contact with gears should be free of wear, roughness or scoring.

4. Inspect front flange and rear cover for damage or wear.

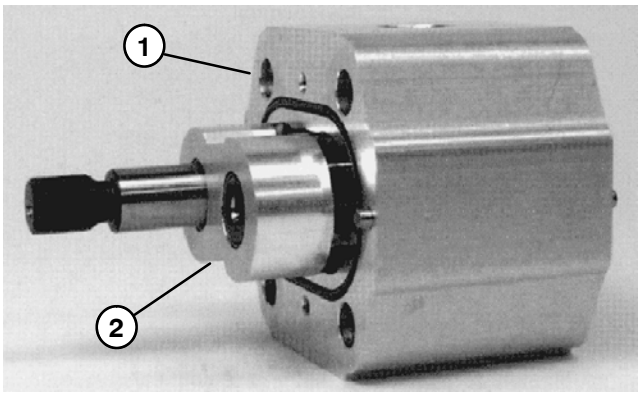

Figure 68

1. **Motor body**
2. **Bearing block & gear set**

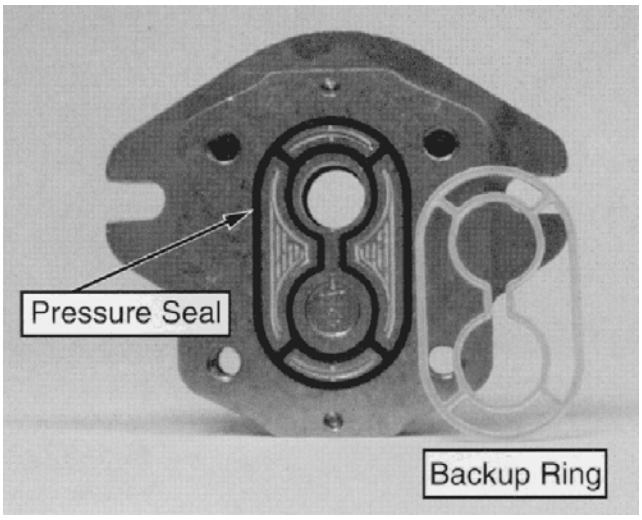

Figure 69

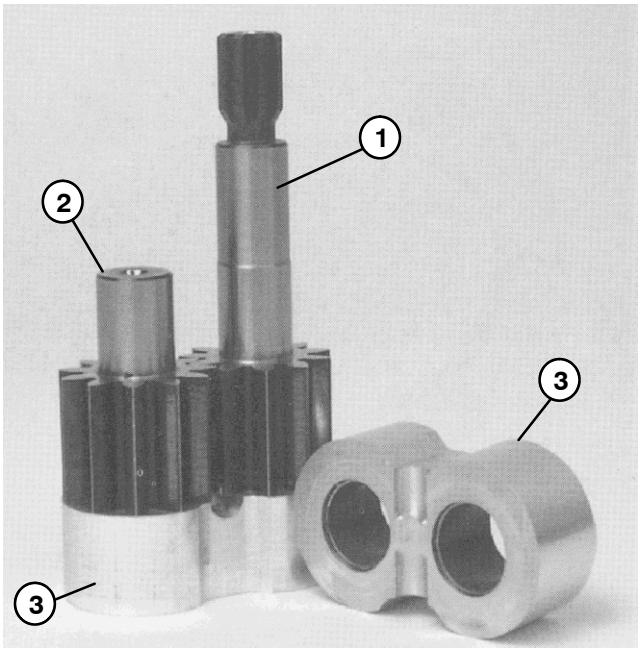

Figure 70

1. **Drive gear**
2. **Idler gear**
3. **Bearing block**

Reassembly

NOTE: When reassembling the motor, check the identification marks made during disassembly to make sure the parts are properly aligned during reassembly.

1. Lubricate o-rings, pressure seals, back-up gaskets, and seal grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install new shaft seal into front flange. Install snap ring into front flange.

3. Install lubricated pressure seals into the grooves in the front flange and rear cover. Follow by carefully placing the back-up rings into the grooves.

4. Install new o-rings to the body.

5. Lubricate gear faces and bearing surfaces of drive gear, idler gear and bearing blocks. Carefully assemble bearing blocks and gears noting identification marks made during disassembly.

6. Position the motor body on its side. Carefully slide bearing block and gear assembly into the body cavity using identification marks made during disassembly.

7. Remove any excess lubrication from mating surfaces of body, rear cover, and front flange. Make sure that these surfaces are clean and dry.

8. Install dowel pins in body.

IMPORTANT: Do not dislodge o-rings, pressure seals, or back-up rings during final assembly.

9. Gently slide the rear cover onto the assembly using marker or scribe mark for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

10. Position the motor with rear cover downwards. Carefully slide the front flange onto the assembly using marker or scribe mark for proper location.

11. Install the four cap screws and hand tighten.

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

12. Place motor front flange in a vise and alternately torque the screws from 33 to 40 ft-lb (45 to 55 N-m).

13. Put a small amount of hydraulic oil in port on motor and rotate driveshaft one revolution. Protect the shaft if using a pliers. If drive shaft binds, disassemble motor and repeat assembly process.

14. Remove motor from vise.

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Lift/Lower Control Valve

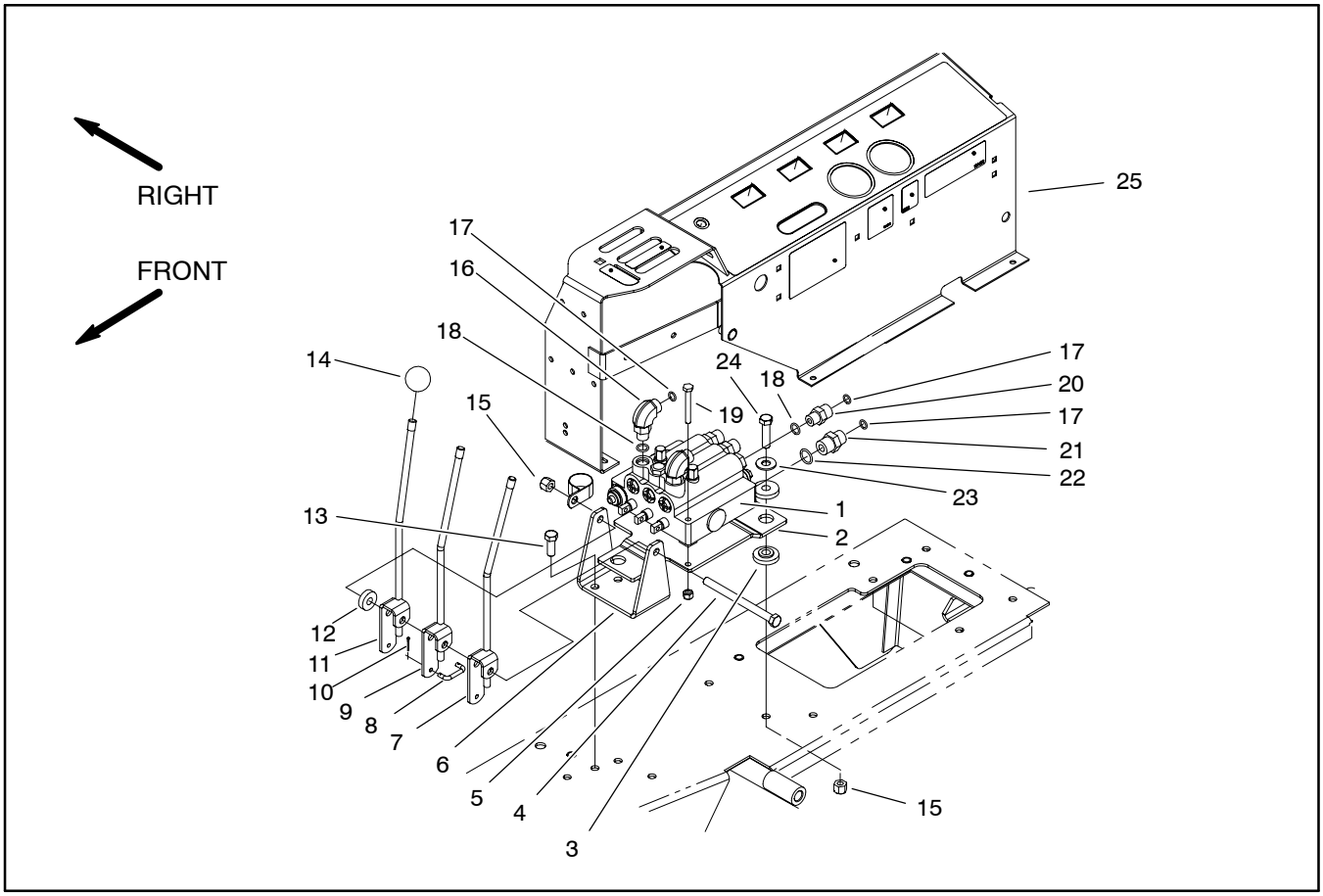

Figure 71

1. Control valve assembly
2. Valve bracket
3. Grommet
4. Cap screw
5. Lock nut
6. Pivot bracket
7. LH lever assembly
8. Lever link
9. Center lever assembly
10. Cotter pin
11. RH lever assembly
12. Spacer
13. Cap screw
14. Knob
15. Lock nut
16. 90º hydraulic fitting
17. O-ring
18. O-ring
19. Cap screw
20. Hydraulic fitting
21. Hydraulic fitting
22. O-ring
23. Flat washer
24. Cap screw
25. Control panel

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. Remove lift/lower control valve using Figure 71 as a guide.

Installation

1. Install control valve using Figure 71 as a guide.

2. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

Lift/Lower Control Valve Service

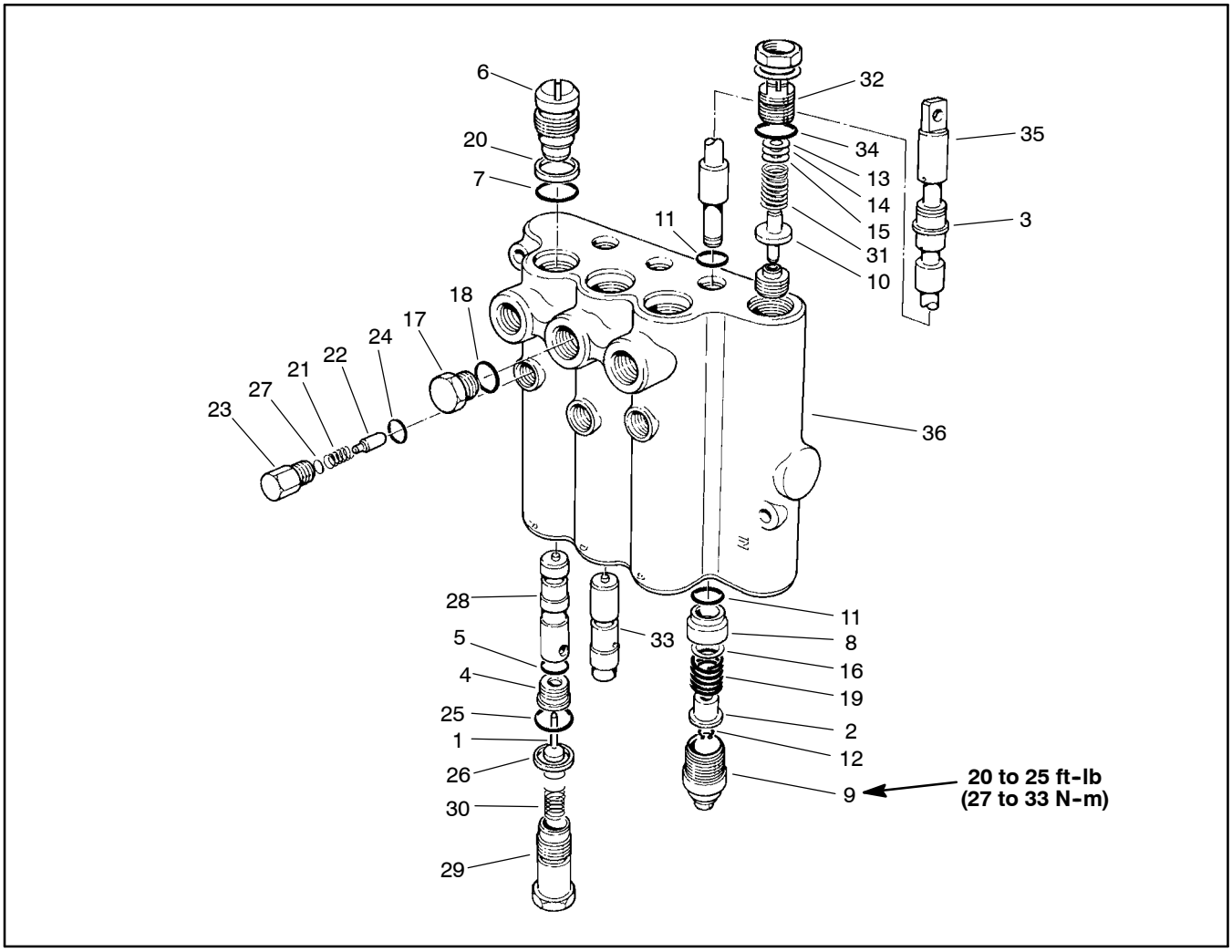

Figure 72

1. Poppet
2. Spacer
3. Wiper
4. Seat
5. O-ring
6. Plug
7. Ring
8. Bushing
9. Cap
10. Relief valve poppet
11. O-ring
12. Retaining ring
13. Washer
14. Washer
15. Washer
16. Washer
17. Plug
18. O-ring
19. Spring
20. Backup washer
21. Detent spring
22. Plunger
23. Plug
24. O-ring
25. O-ring
26. Backup washer
27. Disc
28. Plunger
29. Plug assembly
30. Lockout spring
31. Spring
32. Relief plug assembly
33. Plunger
34. O-ring
35. Spool
36. Body

Disassembly

1. Plug all ports and clean outside of valve thoroughly.

2. Remove caps (9). Do not remove retaining rings (12) from spools unless spring (19) is broken.

NOTE: Spools and spool bores are matched sets. Be sure each spool is identified with the correct body spool bore.

3. Remove spools (35) from body (36).

4. Remove bushings (8) and O-rings (11) from spools.

5. Remove plugs (6).

IMPORTANT: Check location and positioning of plungers when removing from body to assure proper assembly.

6. Remove plugs (29), springs (30), poppets (1), seats (4) and plungers (28 and 33).

7. Remove plug (17).

8. Remove plug (23), disc (27), spring (21) and detent plunger (22).

9. Remove relief plug assembly (32), washers (13, 14, and 15), spring (31) and poppet (10).

10. Remove all O-rings and back-up rings from all plugs and seats.

Inspection

1. Remove all nicks and burns from parts and inspect for excessive wear.

2. Inspect all plungers and poppet seats for burrs or roughness.

3. Inspect spool springs (19), relief valve spring (31), lockout springs (30), and detent spring (21) for breakage.

4. If spools (35) have excessive wear, the control valve becomes non-serviceable as the spools and spool bores are matched. Damaged spools cannot be replaced.

5. Inspect relief valve poppet (10) for breakage or wear.

Assembly

1. Thoroughly clean and dry all parts. Apply a light coating of clean hydraulic oil to parts prior to assembly.

NOTE: All O-rings, back-up washers, wiper seals and nylon poppets should be replaced as new items.

2. Install new O-rings (11) in proper grooves in spool bores.

3. Install relief valve components (13, 14, 15, 31, and 10) with new O-ring (34) on plug assembly (32).

4. Install plugs (6) with new back-up washers (20) and O-rings (7).

5. Install plungers (33 and 28).

IMPORTANT: Check location and positioning of plungers during installation.

6. Install new O-rings (5) on seats (4). Install new back-up washers (26) and O-rings (25) on plugs (29).

7. Install seats (4), new poppets (1), and plugs (29).

8. Install plug (17) with new O-ring (18).

9. Install detent plunger (22), spring (21), disc (27), and plug (23) with new O-ring (24).

10. If retaining ring (12) has been removed to replace spool spring (19), install washer (16), spring (19), spacer (2), and secure with retaining ring (12).

11. Slide bushings (8) over spools. Slide new O-rings (11) over spools and position next to bushings. Dip spools in clean hydraulic oil and install spool assemblies into proper location of body.

12. Install spool caps (9) and tighten from 20 to 25 ft-lb (27 to 33 N-m).

13. Install new wiper seals (3).

Steering Valve

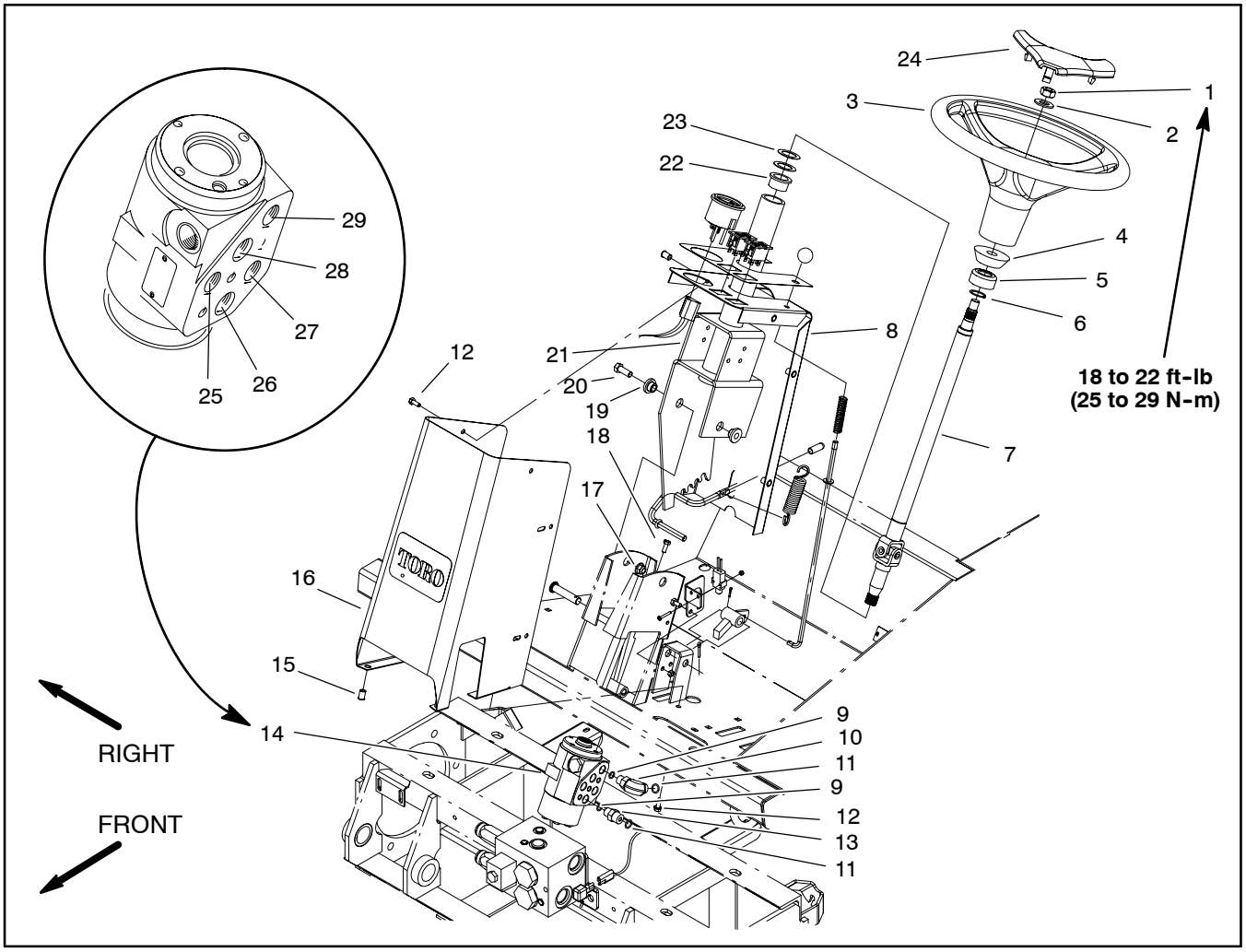

Figure 73

1. Hex nut
2. Flat washer
3. Steering wheel
4. Foam collar
5. Steering seal
6. External snap ring
7. Steering shaft assembly
8. Steering tower cover
9. O-ring
10. 90º hydraulic fitting
11. O-ring
12. Flange head screw
13. Hydraulic adapter
14. Steering valve assembly
15. Nut insert
16. Steering tower
17. Flange locking nut
18. Flange head screw
19. Pivot hub
20. Cap screw
21. Steering column assembly
22. Flange bushing
23. Thrust washer
24. Steering wheel cover
25. In port (P)
26. Right turn port (R)
27. Load sensing port (PB)
28. Left turn port (L)
29. Out port (T)

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. Remove steering valve from machine using Figure 73 as a guide.

Installation

1. Install steering valve using Figure 73 as a guide.

2. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

Steering Valve Service

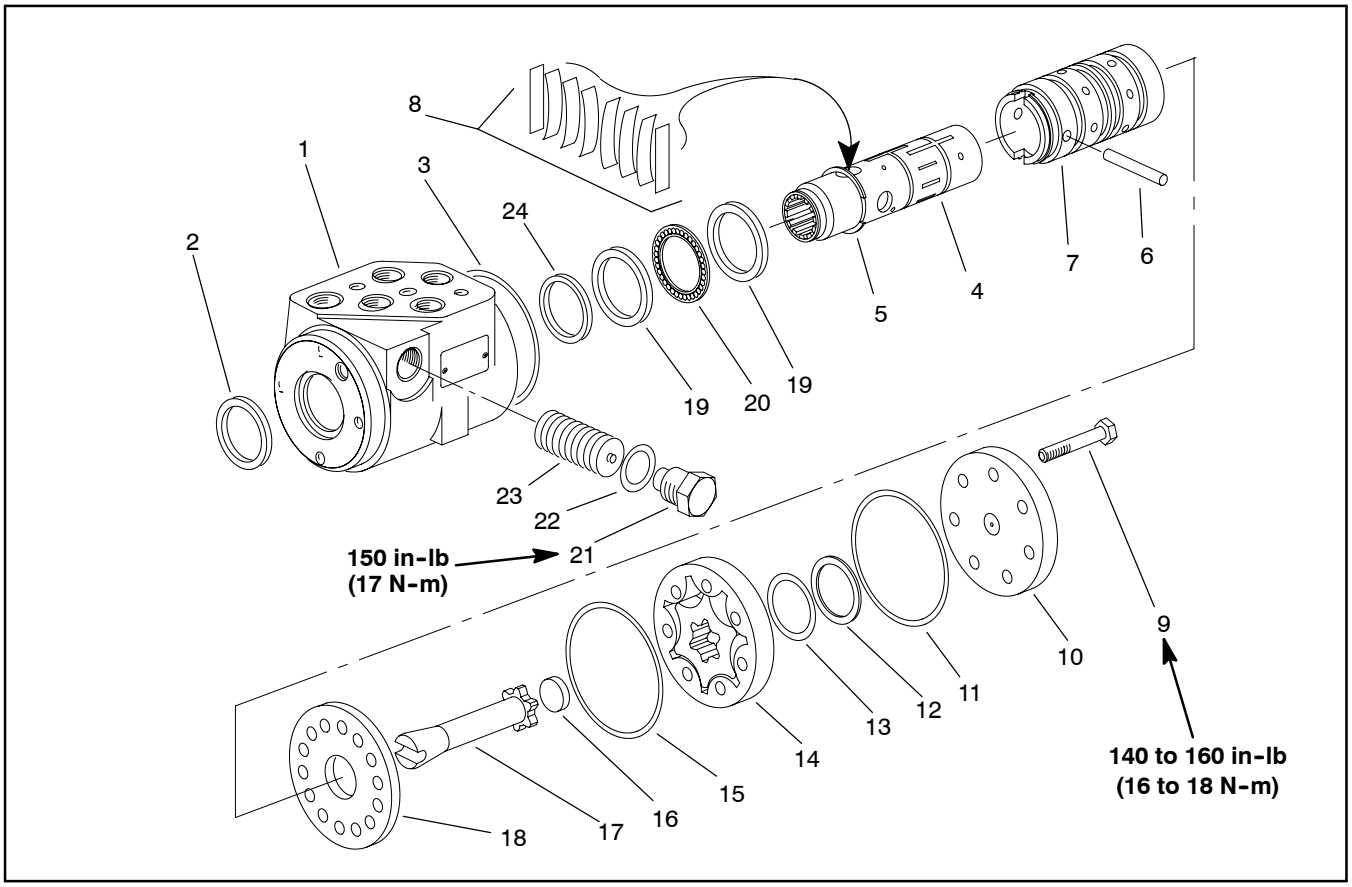

Figure 74

1. **Steering valve housing**
2. **Dust seal**
3. **O-ring**
4. **Spool**
5. **Spring retaining ring**
6. **Pin**
7. **Sleeve**
8. **Centering springs/spacers**
9. **Cap screw**
10. **End cap**
11. **O-ring**
12. **Seal ring**
13. **O-ring**
14. **Geroter**
15. **O-ring**
16. **Spacer**
17. **Geroter drive**
18. **Wear plate**
19. **Bearing race**
20. **Thrust bearing**
21. **Plug**
22. **O-ring**
23. **Relief valve**
24. **Quad seal**

Disassembly

NOTE: Cleanliness is extremely important when repairing steering control units. Work in a clean area. Before disconnecting the hydraulic lines, clean the port area of the steering valve assembly. Before disassembly, drain the oil, then plug the ports and thoroughly clean the exterior. During repairs, always protect machined surfaces.

1. Remove the seven cap screws from the steering valve assembly.

2. Remove end cap, geroter, spacer, geroter drive, wear plate, seal ring, and o-rings from housing (Fig. 74).

3. Remove the plug and relief valve.

4. Slide the spool and sleeve assembly from the housing.

5. Remove the thrust bearing and bearing races (2).

6. Remove the quad seal.

7. Use a small blade screwdriver to carefully pry the dust seal from the housing. Be careful to not damage the dust seal seat in the housing.

8. Remove the pin that holds the spool and sleeve together.

9. Carefully slide the spool out of the sleeve. The centering springs and spring retaining ring will stay with the spool as it is removed.

CAUTION

The centering springs are under tension. Remove the retaining ring carefully.

10. Remove the spring retaining ring and centering springs from the spool.

Reassembly

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with pressurized air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

NOTE: Always use new seals and o−rings when reassembling the steering control unit.

IMPORTANT: During reassembly, lubricate the new seals with petroleum jelly. Also, lubricate machined surfaces and bearings with clean hydraulic fluid.

1. Install the quad seal:

   A. Put one of the bearing races and sleeve into the housing.

   B. Together, the housing and bearing race create a groove into which the quad seal will be installed.

   C. Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.

   D. Fit the quad seal into its seat through the input end of the housing. Be sure the seal is not twisted.

   E. Remove the sleeve and bearing race.

2. Lubricate and install the dust seal.

3. Install the centering springs in the spool. It is best to install the two flat pieces first. Next, install the curved pieces, three at a time.

4. Fit the retaining ring over the centering springs.

5. Apply a light coating of clean hydraulic fluid to the spool and slide it into the sleeve. Be sure the centering springs fit into the notches in the sleeve.

6. Install the pin.

7. Apply a light coating of petroleum jelly to the inner edge of the dust and quad seals.

8. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races (Fig. 75).

IMPORTANT: Do not damage the dust or quad seals when installing the spool and sleeve assembly.

9. Apply a light coating of clean hydraulic fluid to the spool and sleeve assembly and slide carefully the assembly into the housing.

10. Clamp the housing in a vise. Use only enough clamping force to hold the housing securely.

11. Lubricate and install a new o-ring seal in the groove in the housing.

12. Install the wear plate and align screw holes in the wear plate with threaded holes in the housing.

NOTE: The holes in the wear plate are symmetrical.

13. Install the geroter drive, making sure the slot in the drive engages the pin.

14. Lubricate and install new o-ring in wear plate groove.

15. Install the gerotor and align the screw holes.

16. Lubricate and install new o-ring in gerotor ring groove.

17. Lubricate and install new o-ring and seal ring in gerotor star groove.

18. Install the spacer.

19. Install the end cap and seven cap screws. Tighten the cap screws, in a crossing pattern, from 140 to 160 in-lb (16 to 18 N−m).

20. Remove the steering control unit from the vise.

21. Install the relief valve and plug. Tighten the plug to 150 in-lb (17 N−m).

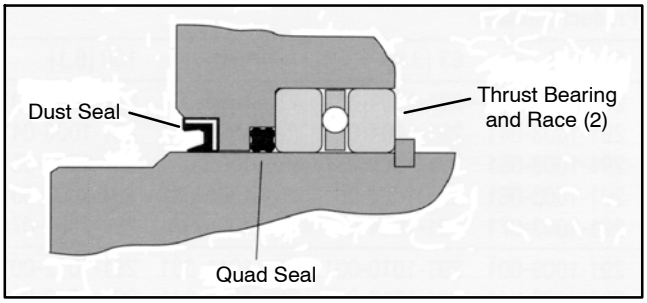

Figure 75

Side Deck Lift Cylinder

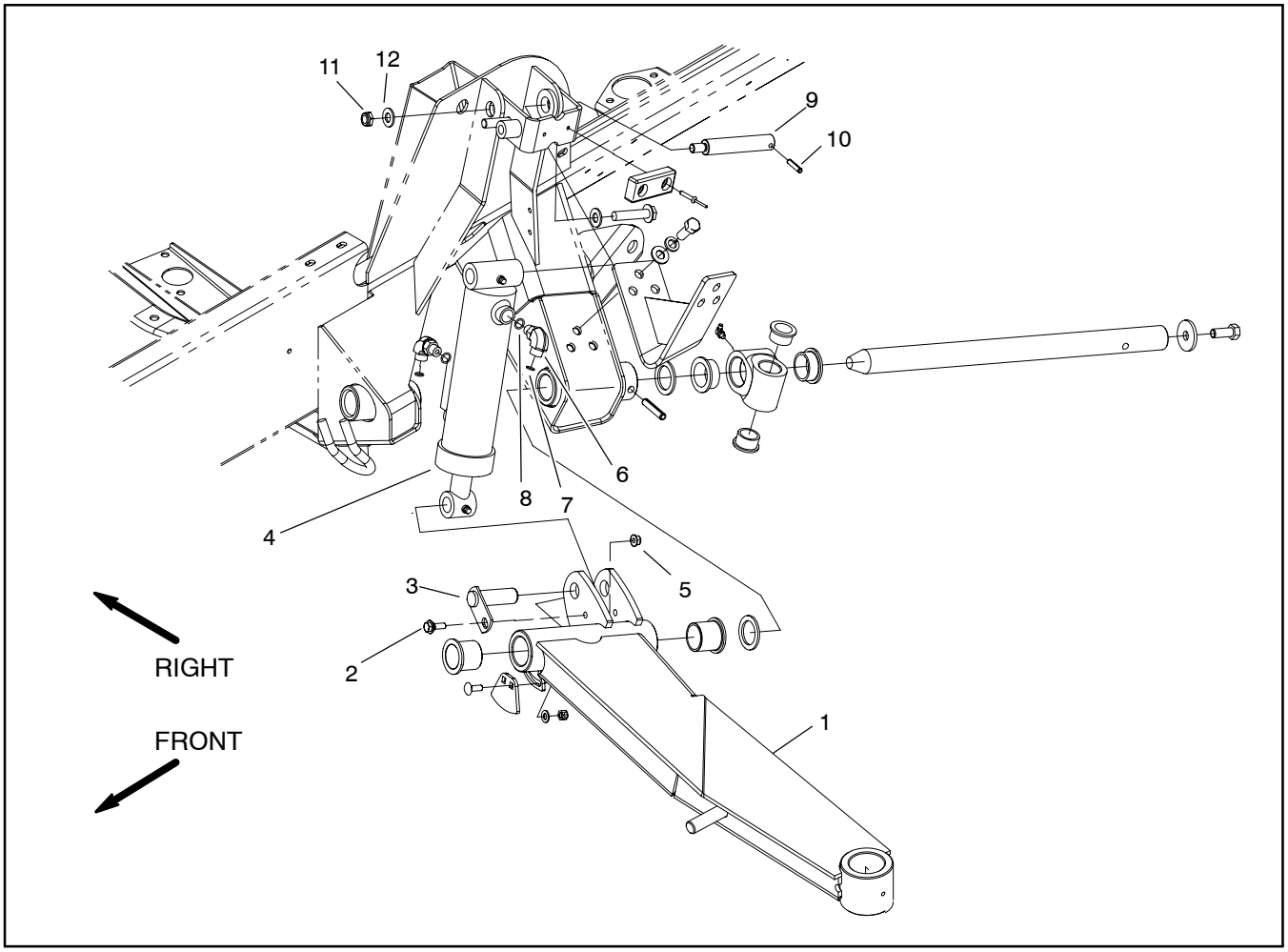

Figure 76

1. **Lift arm assembly (LH shown)**
2. **Shoulder screw**
3. **Pin assembly**
4. **Lift cylinder**
5. **Flange locking nut**
6. **90º hydraulic fitting**
7. **O-ring**
8. **O-ring**
9. **Cylinder pin**
10. **Spring pin**
11. **Lock nut**
12. **Flat washer**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the lift cylinder.

3. Disconnect hydraulic hoses from lift cylinder.

4. Remove shoulder screw and flange locking nut that secure the pin assembly to the lift arm. Remove pin assembly from lift arm and cylinder shaft clevis.

5. Remove lock nut and flat washer from the cylinder pin. Remove cylinder pin with spring pin from the frame and cylinder barrel clevis.

6. Remove lift cylinder from machine.

Installation

1. Position cylinder barrel clevis to frame and insert cylinder pin through the frame and cylinder clevis. Secure pin with flat washer and lock nut.

2. Insert pin assembly through the lift arm and cylinder shaft clevis. Secure pin assembly to lift arm with shoulder screw and flange locking nut.

3. Attach hydraulic hoses to lift cylinder.

4. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

5. After assembly is completed, operate lift cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

Front Deck Lift Cylinder

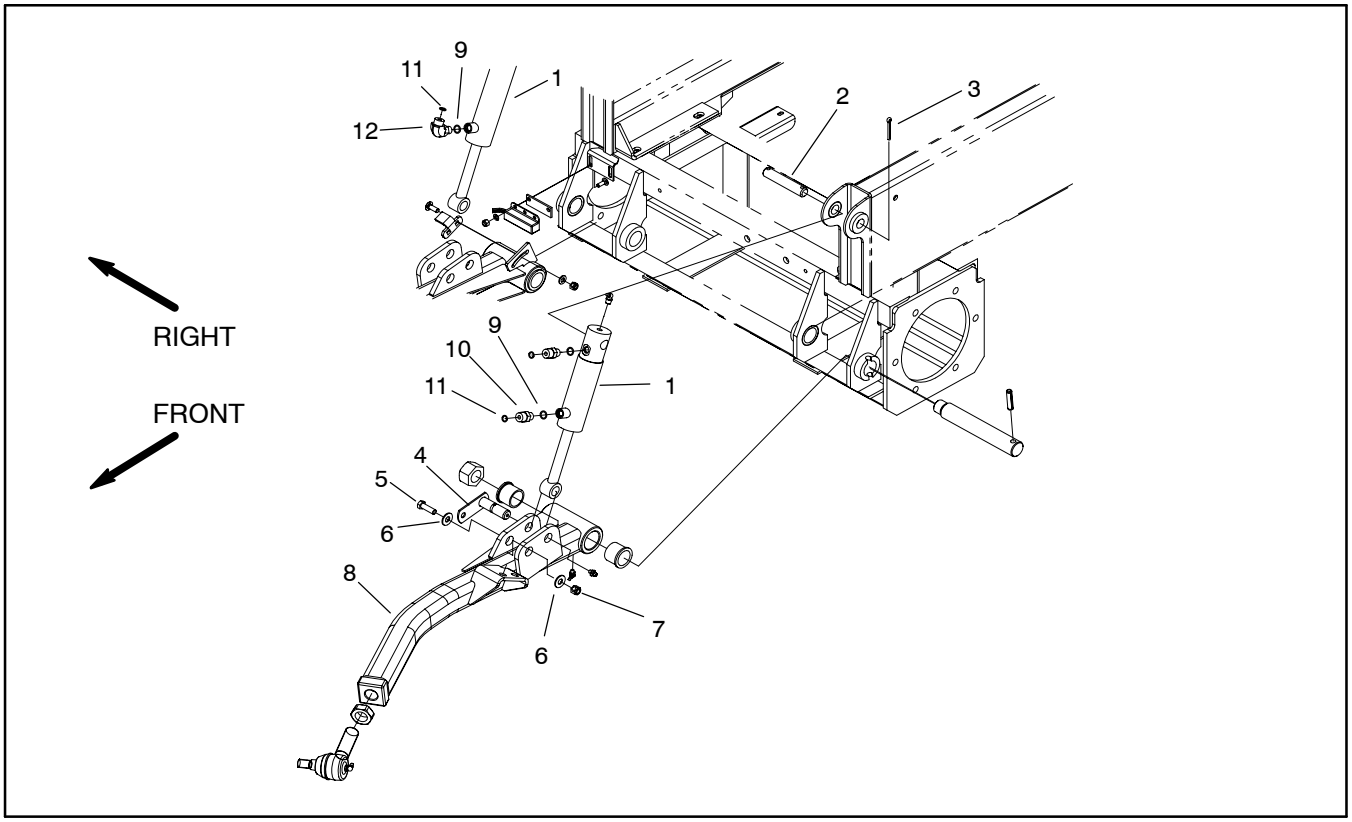

Figure 77

1. **Lift cylinder**
2. **Upper lift pin**
3. **Cotter pin**
4. **Pin assembly**
5. **Cap screw**
6. **Flat washer**
7. **Lock nut**
8. **Lift arm assembly (LH shown)**
9. **O-ring**
10. **Straight hydraulic fitting**
11. **O-ring**
12. **90º hydraulic fitting**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the lift cylinder.

3. Disconnect hydraulic hoses from lift cylinder.

4. Remove lock nut, flat washers, and cap screw that secure the pin assembly to the lift arm. Remove pin assembly from lift arm and cylinder shaft clevis which will free lift cylinder from lift arm.

5. Remove one cotter pin from upper lift pin. Pull upper lift pin from frame and cylinder barrel clevis.

6. Remove lift cylinder from machine.

Installation

1. Position cylinder barrel clevis to frame and insert upper lift pin into frame and clevis. Secure lift pin with cotter pin.

2. Insert pin assembly through lift arm and cylinder shaft clevis. Secure pin to lift arm with cap screw, flat washers, and lock nut.

3. Attach hydraulic hoses to lift cylinder.

4. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

5. After assembly is completed, operate lift cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

Lift Cylinder Service

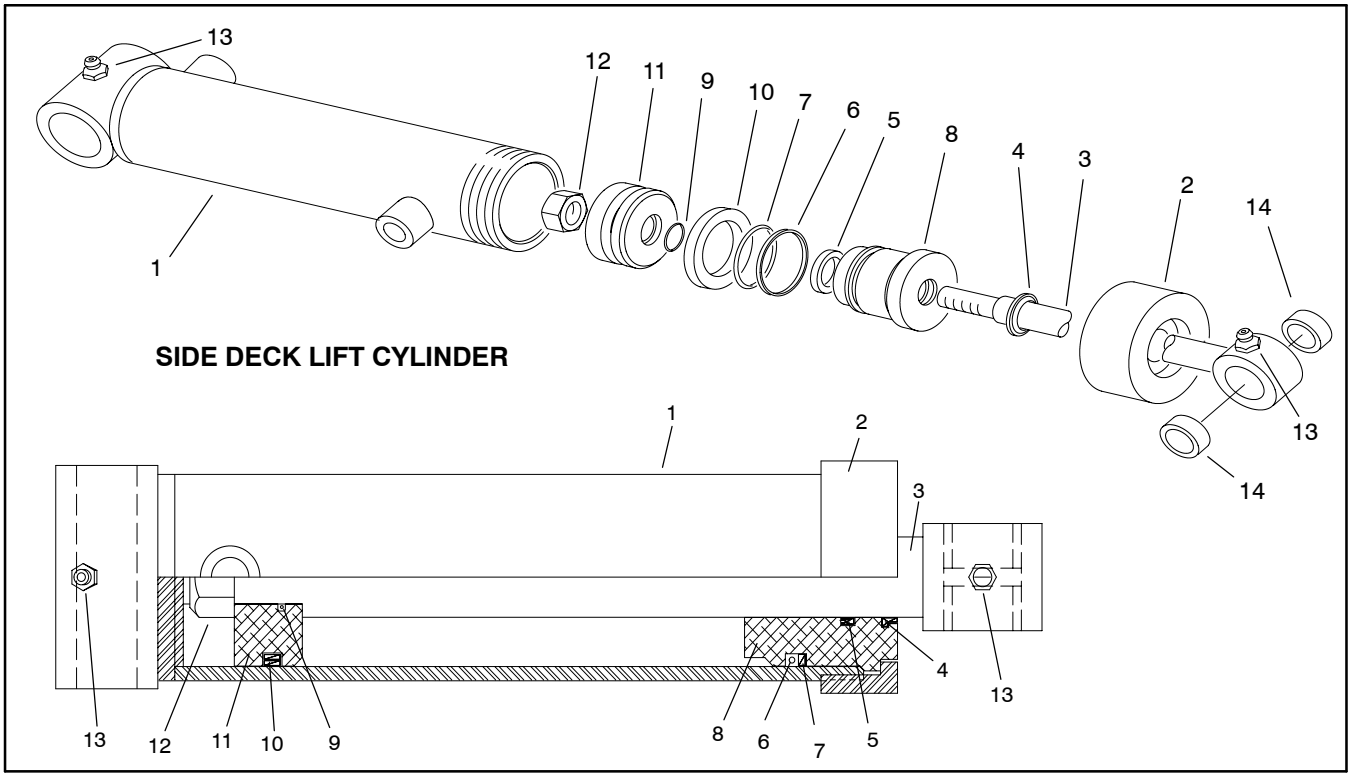

Figure 78

1. Barrel with clevis
2. Collar
3. Shaft with clevis
4. Dust seal
5. Rod seal
6. O-ring
7. Back-up ring
8. Head
9. O-ring
10. Uni-ring
11. Piston
12. Lock nut
13. Grease fitting
14. Bushing

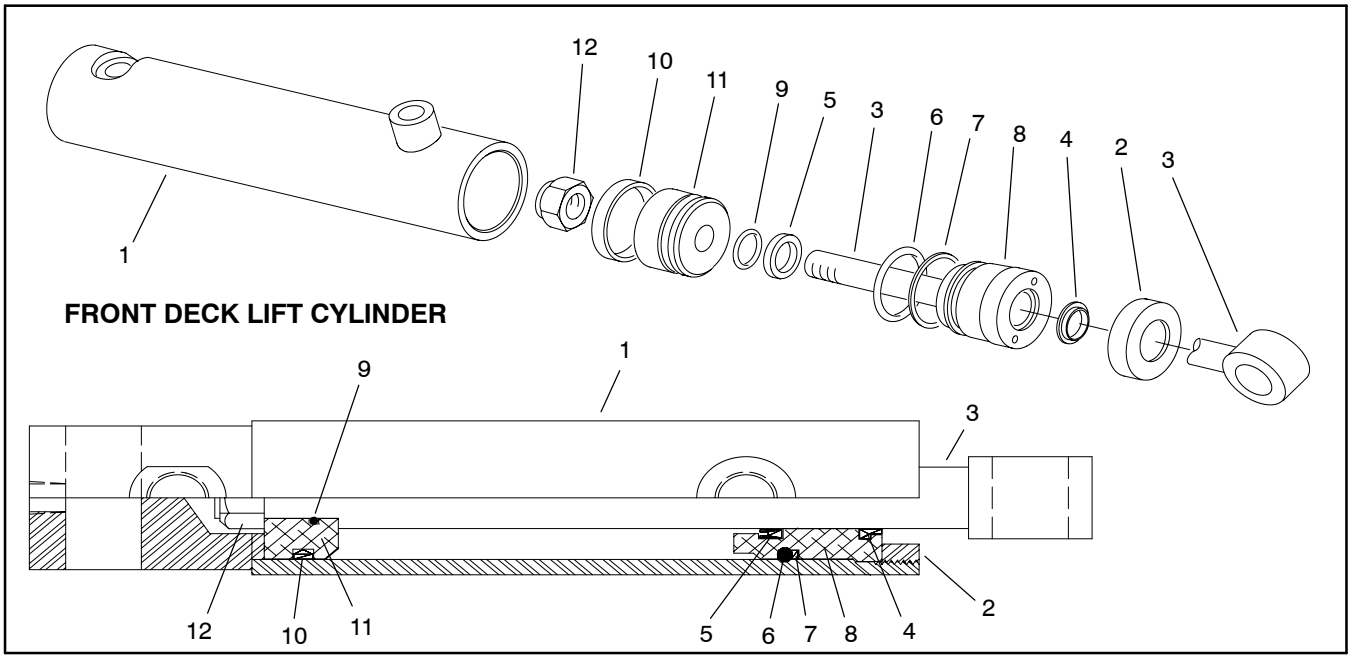

Figure 79

1. Barrel with clevis
2. Collar
3. Shaft with clevis
4. Dust seal
5. Rod seal
6. O-ring
7. Back-up ring
8. Head
9. O-ring
10. Uni-ring
11. Piston
12. Lock nut

Disassembly

1. Remove oil from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the cylinder in a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

2. Mount lift cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.

3. Loosen head from barrel:

   A. On cylinders without a retaining ring slot in the barrel (Figs. 78 and 79), use a spanner wrench to loosen and remove collar from barrel.

   B. On cylinders with a retaining ring (Fig. 80), use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counter−clockwise to remove retaining ring from barrel and head.

4. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vise.

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

6. Remove Uni−ring and O−ring from the piston. Remove O−ring, back−up ring, rod seal, and dust seal from the head.

7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

8. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

Assembly

1. Make sure all parts are clean before assembly.

2. Coat new O−rings, Uni−ring, rod seal, back−up ring, and dust seal with clean hydraulic oil.

   A. Install Uni−ring and O−ring to the piston.

   B. Install dust seal, O−ring, back−up ring, and dust seal to the head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vise.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

   A. Coat shaft with clean hydraulic oil.

   B. If equipped, install collar onto shaft.

   C. Slide head and piston onto the shaft. Secure piston to shaft with lock nut.

4. Lubricate head and piston with hydraulic oil. Slide shaft assembly carefully into cylinder barrel.

IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

5. Mount lift cylinder in a vise with soft jaws. Secure head in barrel:

   A. On cylinders without a retaining ring slot in the barrel (Figs. 78 and 79), use a spanner wrench to tighten collar into barrel.

   B. On cylinders with a retaining ring (Fig. 80), align retaining ring hole in the head with the access slot in the barrel. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

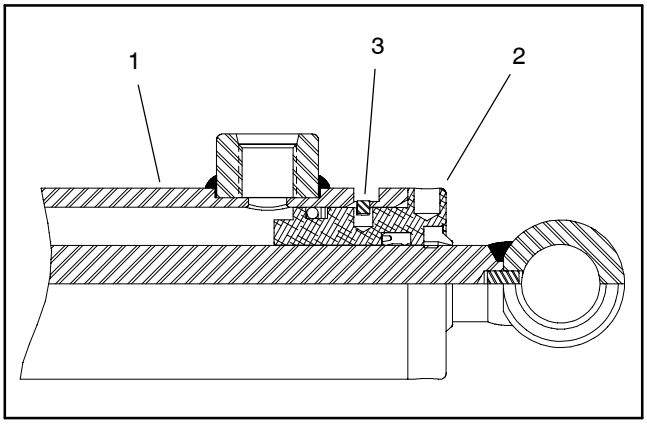

Figure 80

1. **Barrel**
2. **Head**
3. **Retaining ring**

Steering Cylinder

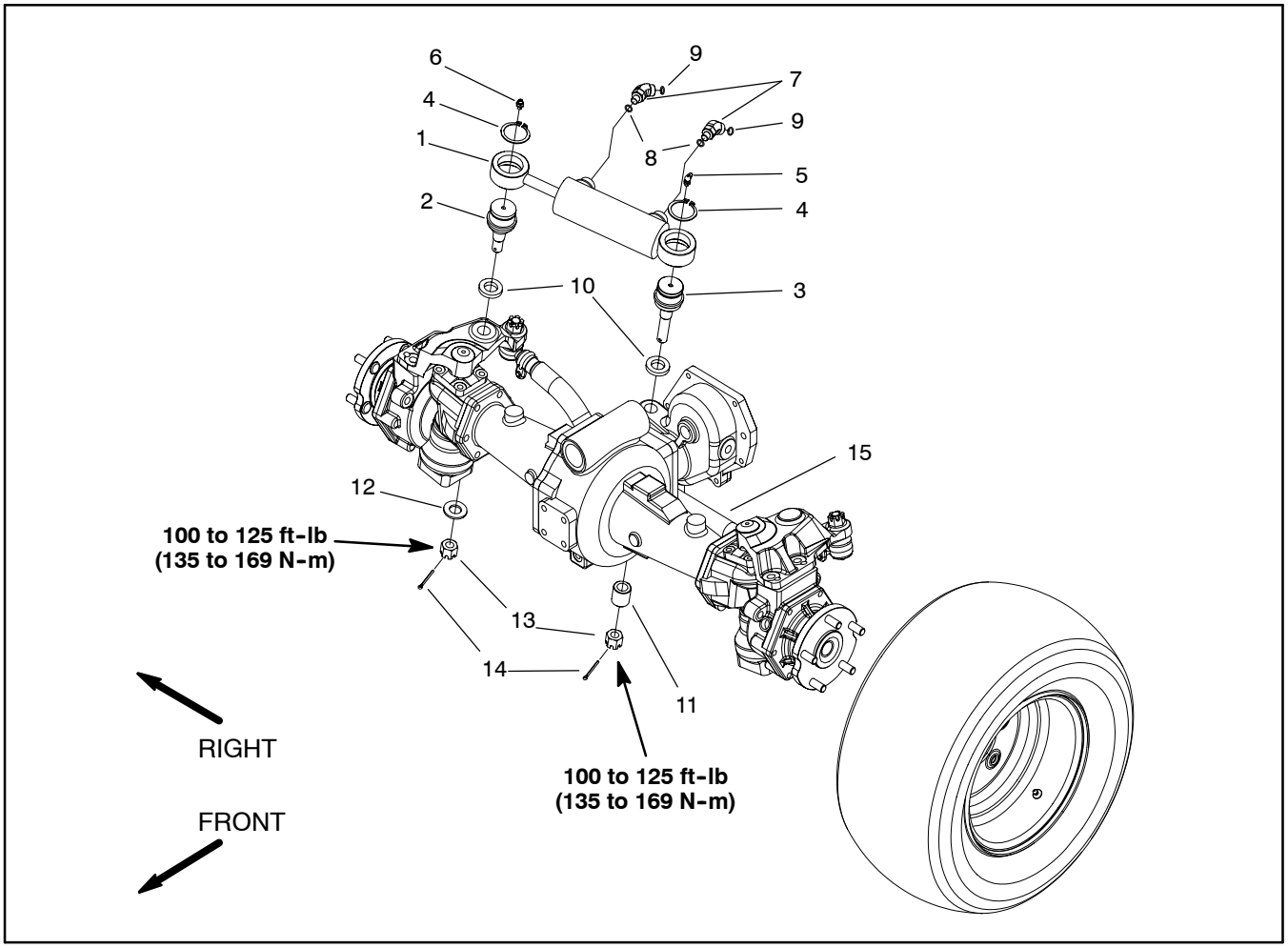

Figure 81

1. **Steering cylinder**
2. **Ball joint**
3. **Ball joint**
4. **Retaining ring**
5. **Grease fitting**
6. **Grease fitting**
7. **90º hydraulic fitting**
8. **O-ring**
9. **O-ring**
10. **Ball joint spacer**
11. **Ball joint spacer**
12. **Axle washer**
13. **Hex slotted nut**
14. **Cotter pin**
15. **Drive axle assembly**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the steering cylinder.

3. Remove hydraulic hoses from steering cylinder.

4. Remove cotter pins, hex slotted nuts, axle washer, and ball joint spacer from the threaded ends of ball joints (Fig. 81). Remove steering cylinder with ball joints from machine. Locate and retrieve ball joint spacers from top of axle assembly.

Installation

1. Place a washer onto each ball joint. Slide ram end ball joint through hole on steering arm. Secure with axle washer and hex slotted nut. Slide fixed end of cylinder through hole on axle. Install spacer onto ball joint and secure with hex slotted nut. Torque slotted nuts from 100 to 125 ft-lbs (135 to 169 N-m) prior to inserting cotter pins.

2. Install hydraulic hoses to steering cylinder.

3. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

4. After assembly is completed, operate steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

Steering Cylinder Service

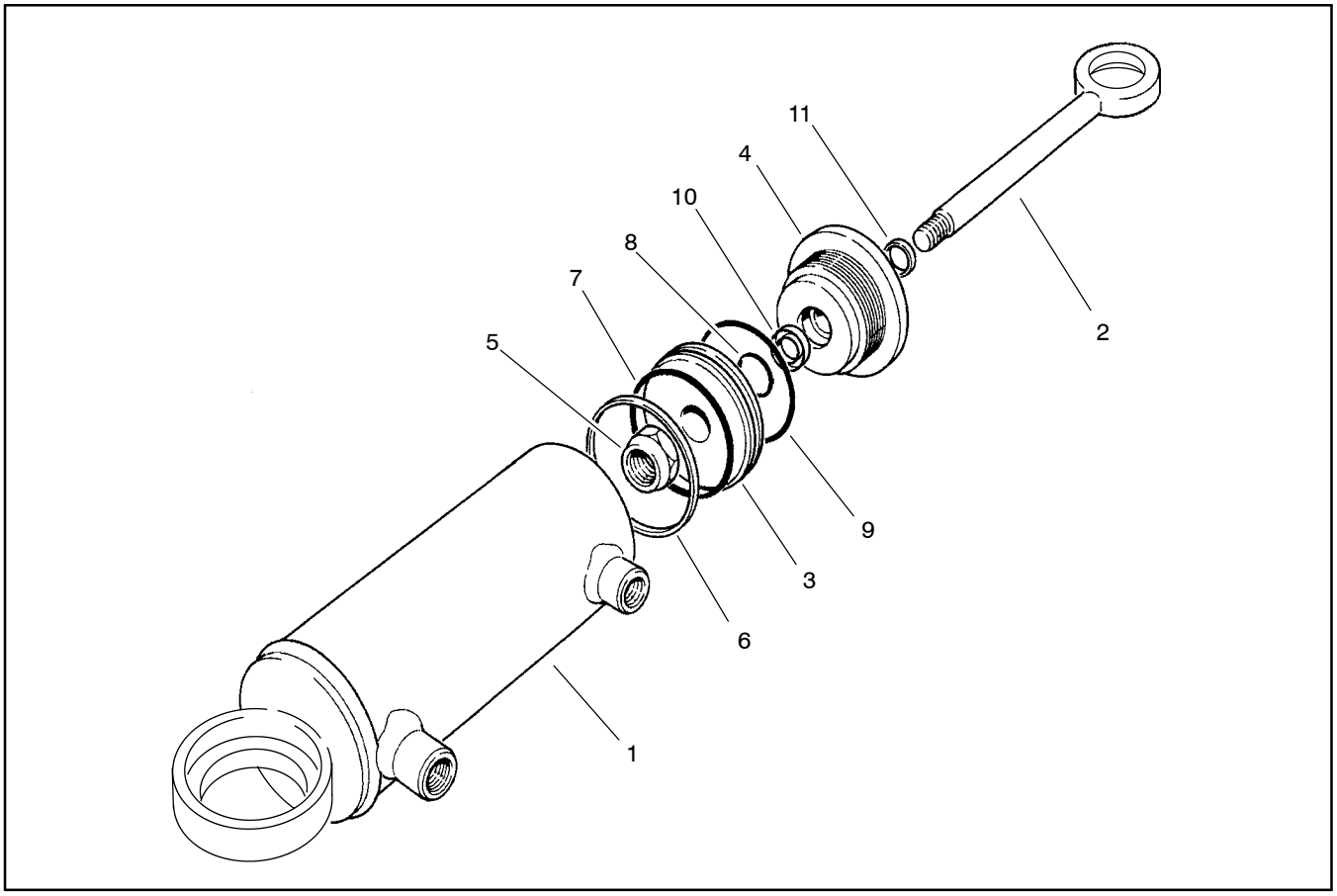

Figure 82

1. **Butt and tube assembly**
2. **Shaft**
3. **Piston rod assembly**
4. **Gland (head)**
5. **Lock nut**
6. **O-ring**
7. **PTFE seal**
8. **O-ring**
9. **O-ring**
10. **U-cup**
11. **Wiper**

Disassembly

1. Pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore. Plug ports and clean outside of cylinder.

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivotal ends. Use of a vise with soft jaws is recommended.

2. Mount cylinder in a vise so piston rod end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted.

3. Loosen gland (head) from barrel:

   A. On cylinders without a retaining ring slot in the barrel (Fig. 82), use a spanner wrench to loosen and remove gland from barrel.

   B. On cylinders with a retaining ring (Fig. 83), use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counter−clockwise to remove retaining ring from barrel and head.

4. Grasp end of piston rod and use a twisting and pulling motion to carefully extract piston, piston rod, and gland from cylinder tube.

IMPORTANT: Do not clamp vise jaws against smooth piston rod surface; the piston rod will become damaged.

5. Securely mount piston, piston rod, and gland into vise and remove lock nut. Remove piston and gland from rod.

6. Remove all seals and O−rings.

7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

8. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

Assembly

1. Use a complete repair kit when rebuilding the cylinder. Put a coating of clean hydraulic oil on all new seals, and O−rings.

2. Install new O−rings and PTFE seal to the piston rod and new O−ring, U−cup, and wiper to gland.

3. Lubricate shaft with clean hydraulic oil. Slide gland and piston onto shaft. Install and tighten lock nut.

4. Put a coating of clean hydraulic oil on all cylinder parts to ease assembly.

5. Slide piston rod assembly into cylinder tube.

6. Mount lift cylinder in a vise with soft jaws. Secure gland (head) in barrel:

   A. On cylinders without a retaining ring slot in the barrel (Fig. 82), use a spanner wrench to tighten gland into barrel.

   B. On cylinders with a retaining ring (Fig. 83), align retaining ring hole in the head with the access slot in the barrel. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

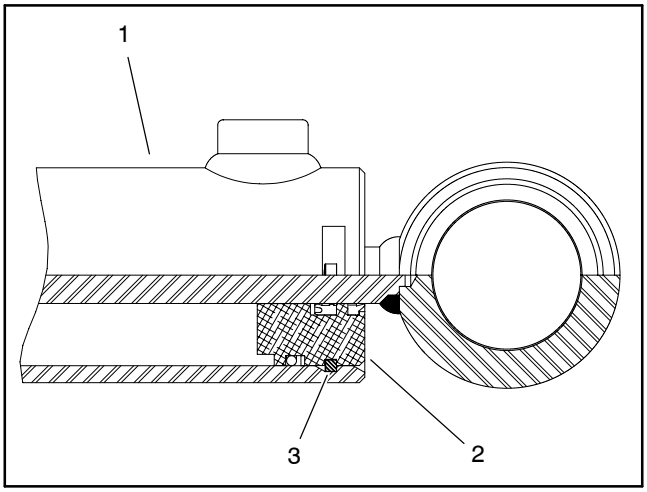

Figure 83

1. **Barrel**
2. **Gland (head)**
3. **Retaining ring**

Hydraulic Reservoir

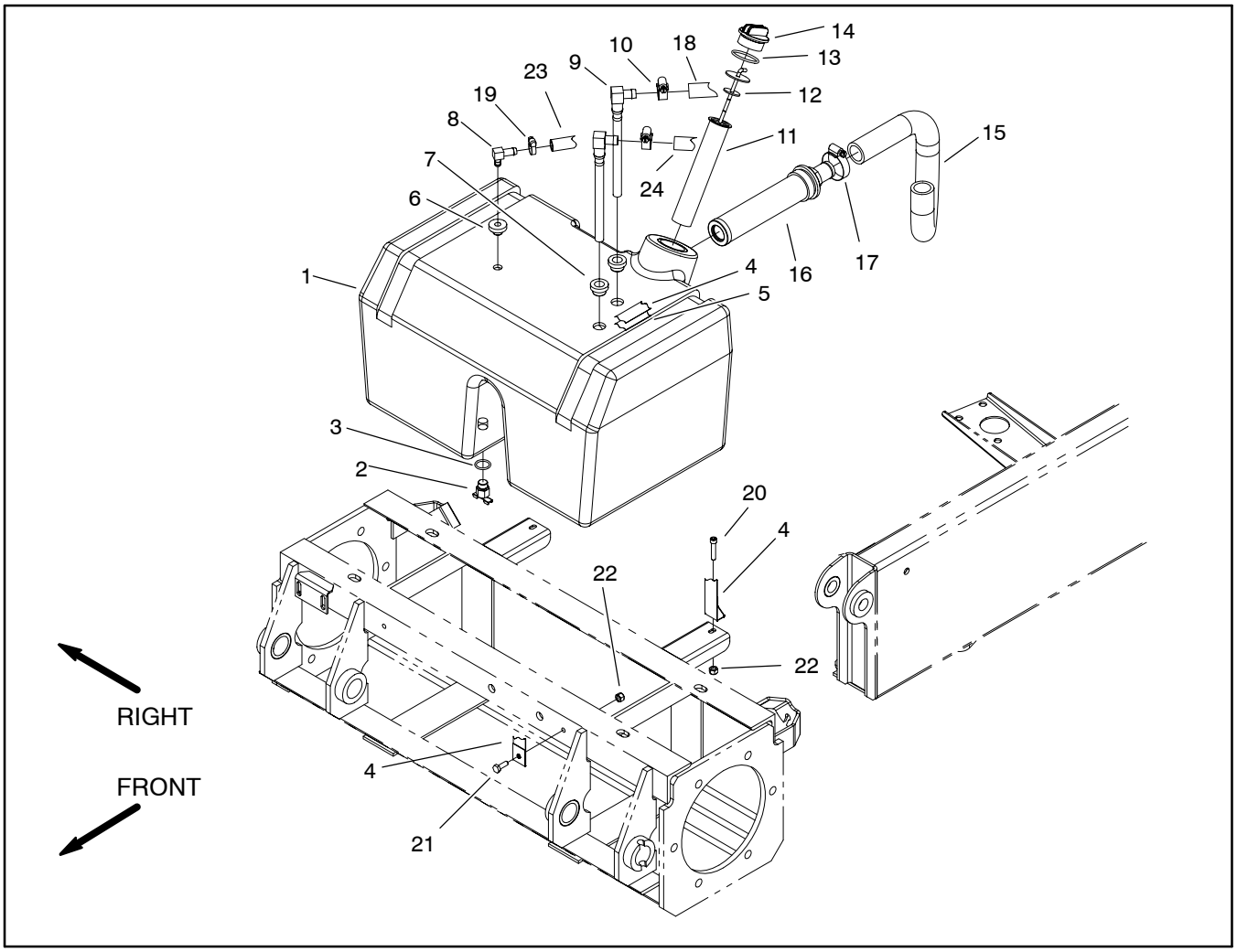

Figure 84

1. **Hydraulic reservoir**
2. **Petcock**
3. **O-ring**
4. **Strap**
5. **Felt strap**
6. **Bushing**
7. **Bushing**
8. **Hydraulic fitting**
9. **Stand pipe**
10. **Hose clamp**
11. **Screen filter**
12. **Dipstick**
13. **O-ring**
14. **Reservoir cap**
15. **Suction hose**
16. **Tank strainer w/o-ring**
17. **Hose clamp**
18. **Hose**
19. **Hose clamp**
20. **Cap screw**
21. **Cap screw**
22. **Lock nut**
23. **Hose**
24. **Hose**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. Drain reservoir into a suitable container (see Operator's Manual).

4. Disconnect hydraulic hoses from reservoir.

5. Remove hydraulic reservoir using Figure 84 as a guide.

Inspection

1. Clean hydraulic reservoir and suction strainer with solvent.

2. Inspect for leaks, cracks, or other damage.

Installation

1. Install reservoir using Figure 84 as a guide.

2. Using a wrench, turn strainer into port at least 1-1/2 to 2 full turns beyond finger tight.

3. Reconnect hydraulic hoses.

4. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

Hydraulic Oil Cooler

Removal

CAUTION

The radiator and oil cooler may be hot. To avoid possible burns, allow the engine and cooling systems to cool before working on the oil cooler.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. Remove oil cooler using Figures 85 and 86 as guides.

Inspection

1. Back flush oil cooler with cleaning solvent. After cooler is clean, make sure all solvent is drained from the cooler.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Dry inside of oil cooler using compressed air in the opposite direction of the oil flow.

3. Plug both ends of oil cooler. Clean exterior of cooler. Make sure fins are clear of dirt and debris.

4. The oil cooler should be free of corrosion, cracked tubes, and excessive pitting of tubes.

Installation

1. Install oil cooler using Figures 85 and 86 as guides.

2. Fill reservoir with hydraulic fluid as required (see Operator's Manual).

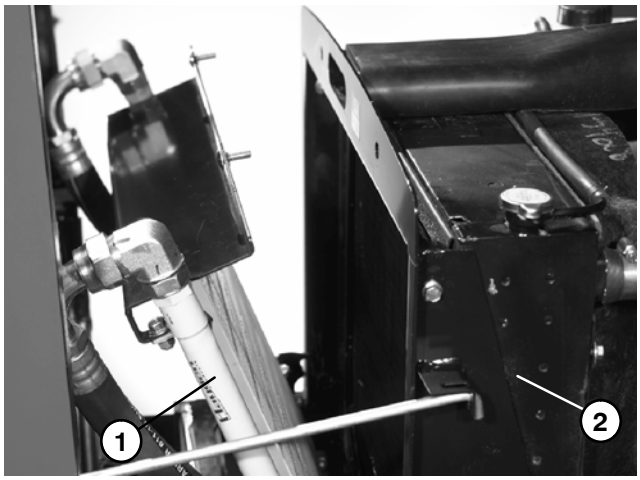

Figure 85

1. **Oil cooler**
2. **Radiator assembly**

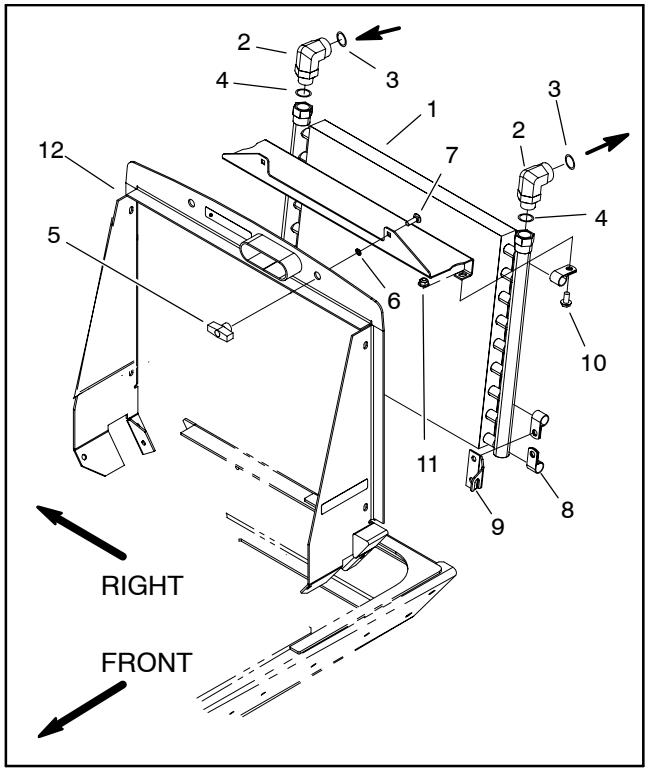

Figure 86

1. **Oil cooler**
2. **90º hydraulic fitting**
3. **O-ring**
4. **O-ring**
5. **Knob**
6. **Retaining ring**
7. **Carriage screw**
8. **Clamp**
9. **Oil cooler bracket (RH)**
10. **Flange screw**
11. **Flange locking nut**
12. **Radiator support**

Chapter 5

Electrical System

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Electrical Schematic, Circuit Diagrams, and Wire Harness Drawings

The electrical schematic, circuit diagrams, and wire harness drawings for the Groundsmaster 4000−D are located in Chapter 9 − Electrical Diagrams.

Special Tools

Order special tools from your Toro Distributor. Some tools may also be available from a local supplier.

Multimeter

The meter can test electrical components and circuits for current, resistance, or voltage.

NOTE: Toro recommends the use of a DIGITAL Volt−Ohm−Amp multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode will make sure that excess current is not allowed through the meter. This excess current can cause damage to circuits not designed to carry it.

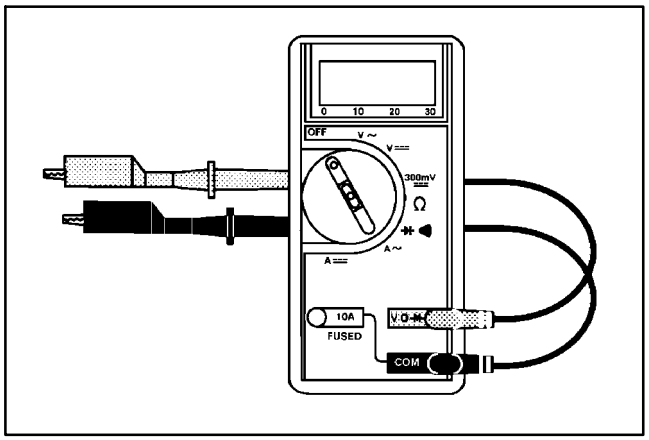

Figure 1

Skin−Over Grease

Special non−conductive grease (Toro Part No. 505−165) which forms a light protective skin which helps waterproof electrical switches and contacts.

Figure 2

Deck Proximity Switch Adjustment Tool

The Deck Proximity Switch Adjustment Tool (TOR4095) is designed to assist in the adjustment of the cutting deck position switches for cutting blade shutdown during deck lift.

Figure 3

Troubleshooting

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Chapter 9 − Electrical Diagrams).

If the machine has any interlock switches by−passed, reconnect the switches for proper troubleshooting and safety.

Starting Problems

Problem	Possible Causes
All electrical power is dead, including gauges.	The battery charge is low. The 10 amp fuse to the ignition switch is open. Bad ground connection on machine. The ignition switch or circuit wiring is faulty. The fusible link from the battery is faulty.
Starter solenoid clicks, but starter will not crank. **NOTE:** If the solenoid clicks, the problem is not in the interlock circuit wiring.	Low battery charge. Loose or corroded battery cables. Loose or corroded ground. Faulty wiring at the starter. Faulty starter solenoid. Faulty starter.
Nothing happens when start attempt is made. Control panel lights and gauges operate with the ignition switch in ON.	The traction pedal is not in neutral position or the neutral switch or circuit wiring is faulty. The cutting units are engaged. Faulty ignition switch or circuit wiring. Start relay or circuit wiring is faulty. Starter solenoid or starter is faulty.
Engine starts, but stops when the ignition switch is released from the START position.	The fuel run solenoid is out of adjustment or circuit wiring is faulty. High temperature shutdown switch or circuit wiring is faulty.

Problem	Possible Causes
Engine cranks, but does not start.	Engine is not cranking fast enough. Engine fuel stop solenoid, circuit wiring, or fuel pump is faulty. The problem is not electrical (see Chapter 3 − Kubota Engine).
Starter cranks, but should not when the traction pedal is depressed.	The traction neutral switch is out of adjustment. The traction neutral switch or circuit wiring is faulty.

General Run and Transport Problems

Engine continues to run, but should not, when the ignition switch is turned off.	The engine fuel stop solenoid is stuck open. Ignition switch or circuit wiring is faulty.
Engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	The seat sensor or circuit wiring is faulty. Traction neutral switch or circuit wiring is faulty.
The engine stops during operation, but is able to restart.	The operator is lifting off the seat switch. The seat switch or circuit wiring is faulty. The engine shutdown delay is faulty. The ignition switch or circuit wiring is faulty.
The engine kills when the traction pedal is depressed.	The operator is lifting off the seat switch. The seat switch or circuit wiring is faulty.
Battery does not charge.	Loose, corroded, or broken wire(s). The fusible link to the battery is faulty. Faulty alternator or dead battery. Charge indicator lamp is faulty or burned out. Charge indicator lamp wiring loose, corroded, or damaged.

Cutting Unit Operating Problems

The cutting units remain engaged, but should not, with no operator in the seat.	The seat switch or circuit wiring is faulty.
Cutting units run, but should not, when raised. Units shut off with PTO switch.	The deck position switch or circuit wiring is faulty.
Cutting units run, but should not, when raised. Units do not shut off with the PTO switch.	The deck position switch or circuit wiring, and PTO switch or circuit wiring are faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 − Hydraulic System).
Cutting units run, but should not, when lowered with PTO switch in the OFF (disengage) position.	The PTO switch or circuit wiring is faulty.
Cutting deck(s) do not operate.	The operator is lifting off the seat switch. The seat switch or circuit wiring is faulty. The PTO switch or circuit wiring is faulty. The deck position switch or circuit wiring is faulty. Hydraulic valve solenoid(s) or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 − Hydraulic System).
PTO fuse blows when engaging cutting deck	Hydraulic valve solenoid coil is shorted. Cutting deck position switch is faulty.

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 60 to 100ºF (16 to 38ºC). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (−) meter lead to the negative battery post.

NOTE: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

Voltage Measured	Battery Charge Level
12.68 V (or higher)	Fully charged (100%)
12.45 V	75% charged
12.24 V	50% charged
12.06 V	25% charged
11.89 V	0% charged

Check Operation of Interlock Switches

CAUTION

Do not disconnect safety switches. They are for the operator's protection. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Interlock switch operation is described in the Operator's Manual. Testing of interlock switches and relays is included in the Component Testing section of this Chapter.

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check).

NOTE: For engine component testing information, see the Kubota Workshop Manual, Diesel Engine, V2003−T Series at the end of Chapter 3 − Kubota Diesel Engine.

CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Ignition Switch

The ignition (key) switch has three positions (OFF, ON/PREHEAT, and START). The terminals are marked as shown. The circuit wiring of the ignition switch is shown in the chart. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

POSITION	CIRCUIT
OFF	NONE
ON / PREHEAT	B + I + A, X + Y
START	B + I + S

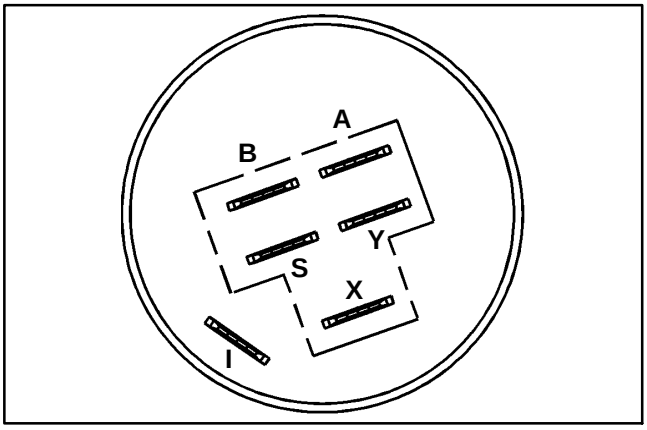

Figure 4

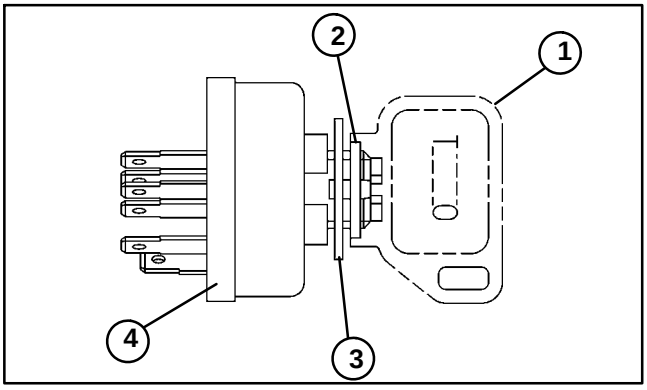

Figure 5

1. **Key**
2. **Hex nut**
3. **Lock washer**
4. **Ignition switch**

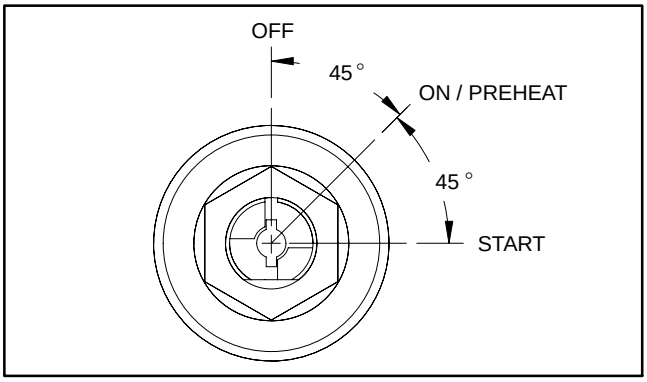

Figure 6

Fuses

The fuse blocks are located under the operator's control panel.

Identification, Function, and Wiring

The fuses are held in two fuse blocks. Use Figure 7 to identify each individual fuse and its correct amperage. Each fuse holder has the following functions and wire connected to it.

Fuse A1

A. Supplies power to the seat switch.

B. Has green wire and red wire (battery).

Fuse A2

A. Supplies power to ignition switch terminal B.

B. Has pink wire and red wire (battery).

Fuse A3

A. Supplies power to the PTO switch.

B. Has yellow wire and red wire (battery).

Fuse A4

A. Supplies power to the starter solenoid.

B. Has orange wire and red wire (battery).

Fuse B1

A. Supplies power to the power point outlet.

B. Has white wire and red wire (battery).

Fuse B4 (when optional lighting is installed)

A. Supplies power for optional light kit.

B. Has two red wires.

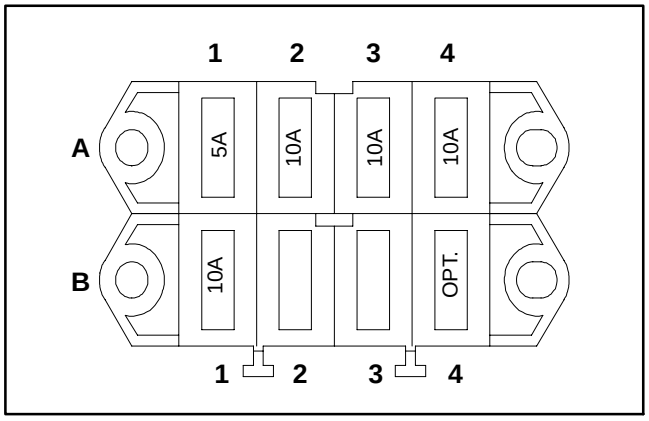

Figure 7

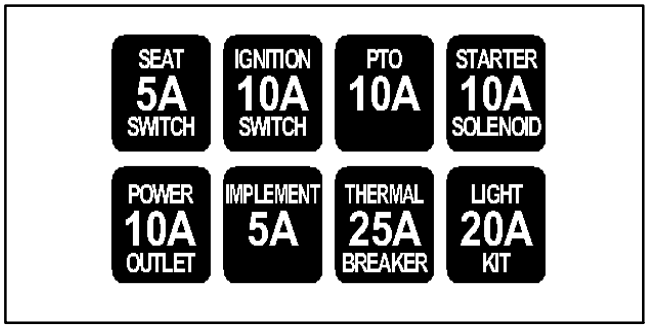

Figure 8

Warning Lights

Testing Warning Lights

1. Apply 12 VDC to terminals 1A and 2A.

2. Ground terminals 1B and 2B.

3. Both indicator lights should light.

Engine Oil Pressure Light

The oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should light with the engine running when the oil pressure drops below 7 PSI (0.5 kg/cm^2).

1. Disconnect green wire from the oil pressure switch.

2. Ground green wire to the engine block.

3. Turn ignition switch to ON; the oil pressure light should come on indicating correct operation of the electrical wiring to the oil pressure switch.

4. Turn ignition switch to OFF. Reconnect green wire to the oil pressure switch.

High Temperature Shutdown Light

If the coolant temperature rises to 230ºF (110ºC), the high temperature light should come on as the high temperature shutdown switch stops the engine.

1. Ground the wire attached to temperature switch on flywheel end of engine. Warning light and audible alarm should go on and engine should stop running.

2. Depress alarm silence and alarm should turn off. Depress high temperature override and hold, engine should start and run.

3. Reconnect wire to temperature switch.

Glow Plug Indicator Light

The glow plug indicator light should come on when the ignition switch is placed in ON prior to placing the ignition switch in START. The light should stay lit for 10 seconds while the ignition switch is left in ON.

Charge Indicator Light

The charge indicator light should come on when the ignition switch is in ON with the engine not running, or with an improperly operating charging circuit while the engine is running.

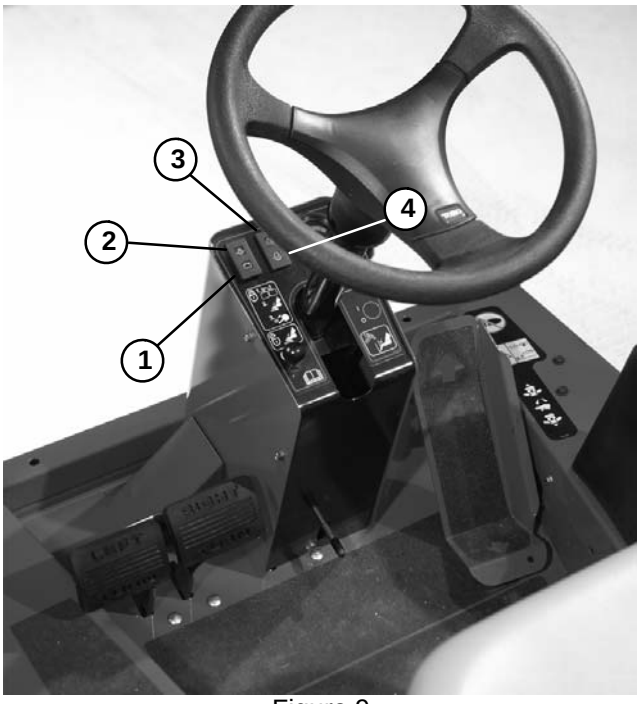

Figure 9

1. **Charge indicator**
2. **Engine oil pressure**
3. **High temp shutdown**
4. **Glow plug indicator**

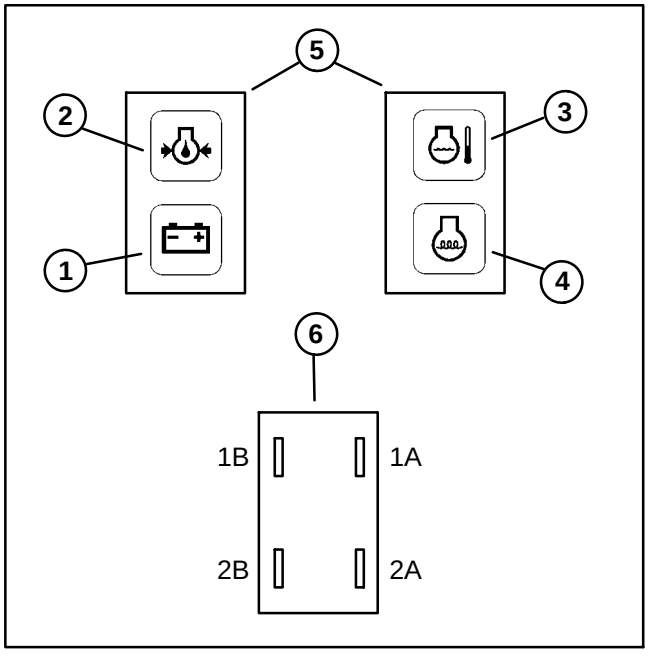

Figure 10

1. **Charge indicator**
2. **Engine oil pressure**
3. **High temp shutdown**
4. **Glow plug indicator**
5. **Warning light front**
6. **Warning light back**

PTO Switch

The PTO switch is attached to the control console next to the operator seat (Fig. 11).

The switch terminals are marked as shown in Figure 12. The circuitry of the PTO switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

NOTE: The PTO ON position requires lifting and pushing the lever toward the switch keyway. The PTO OFF position occurs when the lever is pushed opposite the keyway.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
PTO ON	2 + 3	5 + 6
CENTER	1 + 2	5 + 6
PTO OFF	1 + 2	4 + 5

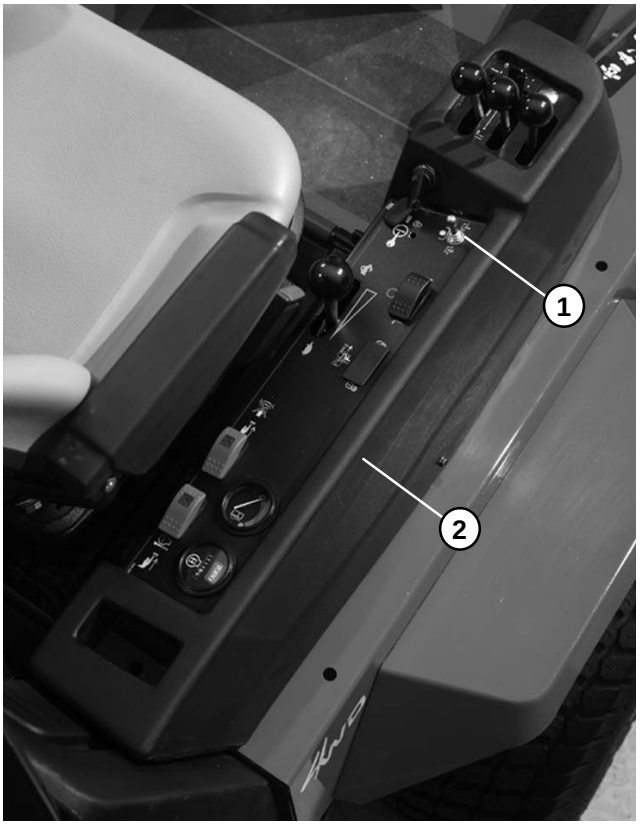

Figure 11

1. PTO switch **2. Control console**

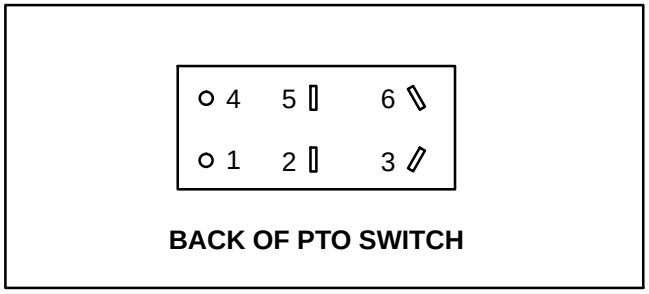

Figure 12

Transport, Alarm Silence, and Temperature Override Switches

The transport, alarm silence, and temperature override rocker switches are located on the control console (Fig. 13). These switches have common switching logic.

The switch terminals are marked as shown in Figure 14 and Figure 15. The circuitry of these switches is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ON	2 + 3	5 + 6
OFF	1 + 2	4 + 5

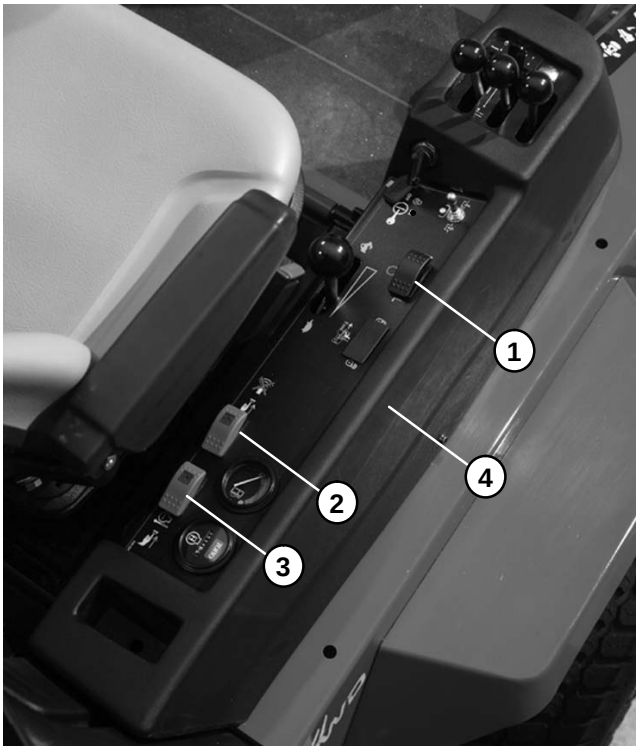

Figure 13

1. **Transport switch**
2. **Alarm silence switch**
3. **Temp. override switch**
4. **Control console**

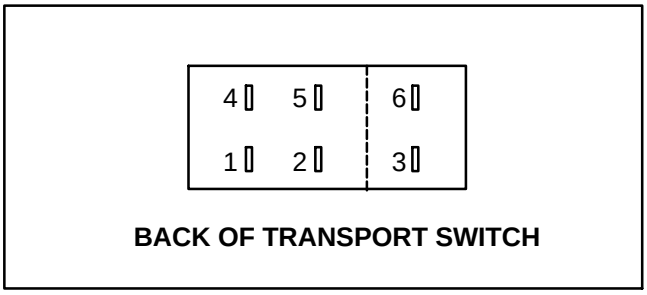

Figure 14

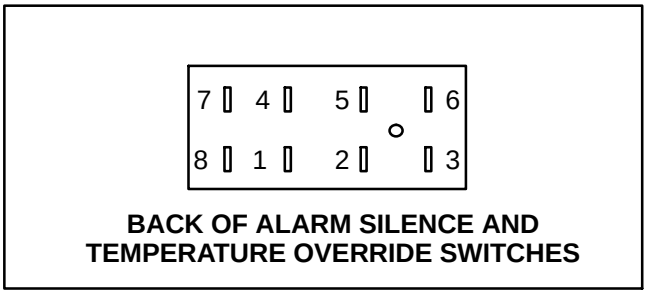

Figure 15

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the traction system or PTO switch is engaged when the operator raises out of the seat, the engine will stop. The seat switch and its electrical connector are located directly under the seat. Testing of the switch can be done without seat removal by disconnecting the seat wire from the machine wiring harness.

1. Make sure the engine is off.

2. Disconnect electrical connector for the seat switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

4. With no pressure on the seat, there should be no continuity between the seat switch terminals.

5. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.

6. Reconnect switch connector.

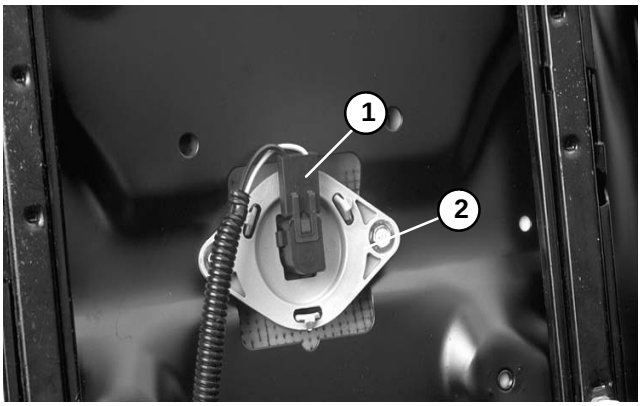

Figure 16

1. Electrical connector **2. Seat switch**

Parking Brake Switch

The switch used for the parking brake is a normally closed switch. The parking brake switch is located under the steering tower cover and opens when the parking brake lever is engaged.

1. Make sure the engine is off. Locate switch for testing.

2. Disconnect electrical connector from the switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

4. When the switch plunger is extended there should be continuity between the switch terminals.

5. When the switch plunger is depressed, there should be no continuity between the switch terminals.

6. Reconnect switch connector.

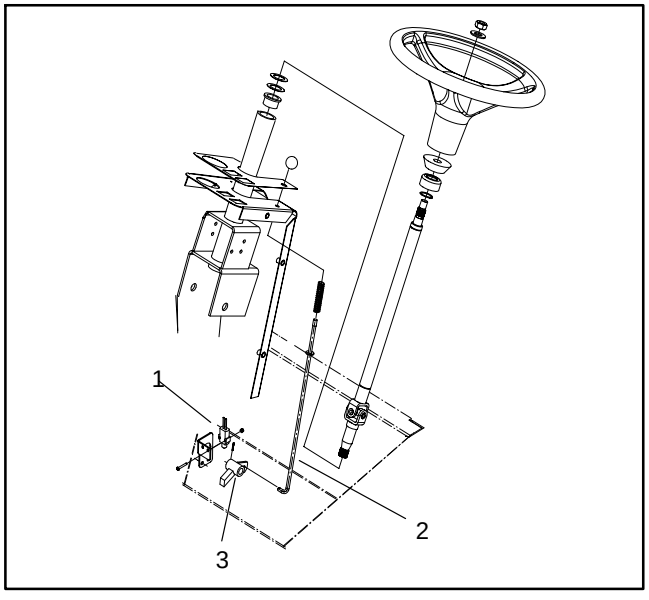

Figure 17

1. Parking brake switch **3. Parking brake pawl**
2. Parking brake rod

Hour Meter

The hour meter is located on the control console next to the operator seat.

1. Connect the positive (+) terminal of a 12 VDC source to the positive (+) terminal of the hour meter.

2. Connect the negative (−) terminal of the voltage source to the other terminal of the hour meter.

3. The hour meter should move a 1/10 of an hour in six minutes.

4. Disconnect voltage source from the hour meter.

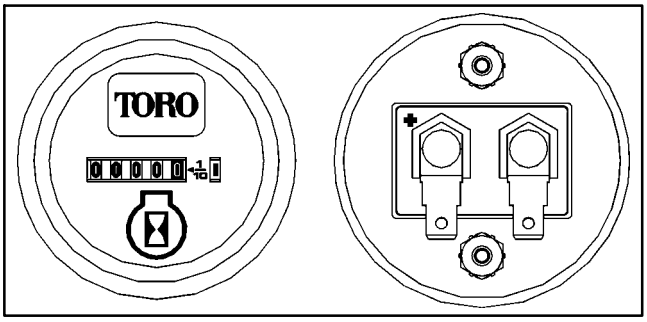

Figure 18

Audio Alarm

The audio alarm for low engine oil pressure or high engine coolant temperature is attached to the control console next to the operator seat.

IMPORTANT: Make sure to observe polarity on the alarm terminals when testing. Damage to the alarm may result from an improper connection.

1. Isolate alarm from the circuit. Correctly connect 12VDC source to the terminals (Fig. 19).

2. Alarm should sound. Remove voltage source from the alarm. Reconnect alarm to the circuit.

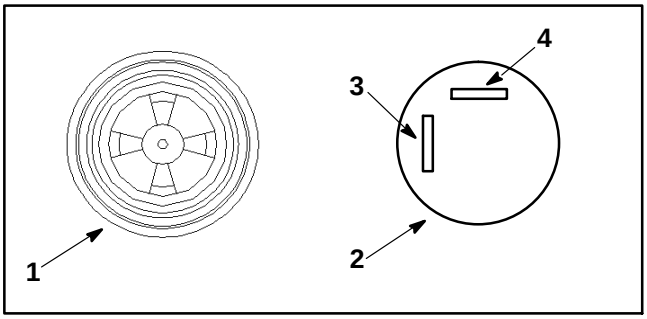

Figure 19

1. Top view
2. Bottom view
3. Positive (+) terminal
4. Negative (−) terminal

Glow Relay

The glow relay is attached to the the right side of the fuel tank support under the hood.

NOTE: Prior to taking small resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting). Resistance should be from 41 to 51 ohms.

2. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

3. Disconnect voltage and leads from the terminals.

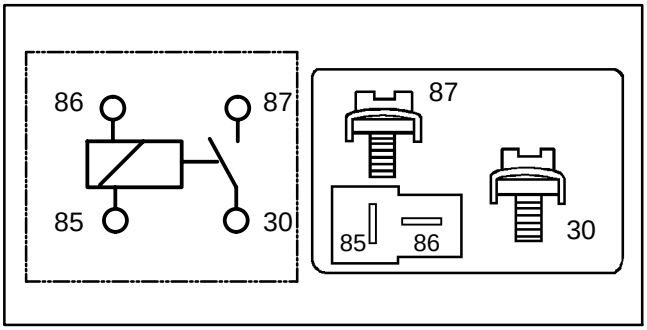

Figure 20

Start, Engine Shutdown, Seat, PTO, Alarm, and Over Temperature Relays

These six relays are located under the console housing cover. The wiring harness is tagged to identify each relay.

NOTE: The relays may be manufactured by one of two different manufacturers. Verify manufacturer name and part number before performing the resistance check on the relay coil.

NOTE: Prior to taking small resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Verify coil resistance between terminals 85 and 86 with a multimeter (ohms setting):

   A. For the Potter & Brumfield relay (#VF4−65F11), resistance should be from 85 to 95 ohms.

   B. For the Hella Electronics relay (#66211), resistance should be from 70 to 80 ohms.

2. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

3. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

4. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.

5. Disconnect voltage and multimeter leads from the relay terminals.

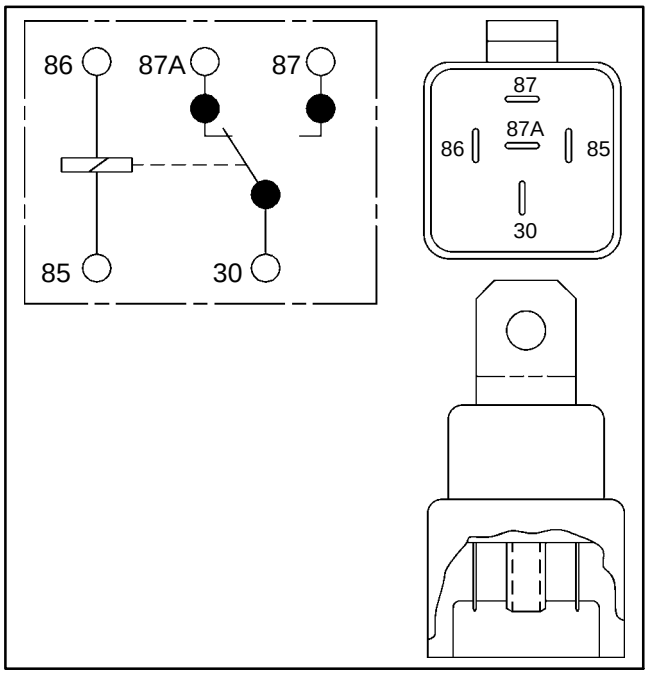

Figure 21

Hydraulic Valve Solenoids

There are four hydraulic valve solenoids on the Groundsmaster 4000−D (Fig. 23). Testing of these solenoids can be done with the solenoid on the hydraulic valve.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Make sure engine is off. Disconnect hydraulic valve solenoid electrical connector (Fig. 22).

2. Apply 12VDC source directly to the solenoid. Listen for solenoid to switch on.

3. Remove 12VDC source from the solenoid. Listen for solenoid to switch off.

4. Measure resistance between the two connector terminals. The resistance for the solenoid coil should be about 7.2 ohms.

5. Install **new** solenoid if necessary.

   A. Apply “Loctite 242” or equivalent to threads on end of valve stem before installing nut.

   B. Torque solenoid nut to specification identified in Figure 23. Over−tightening may damage the solenoid or cause the valve to malfunction.

6. Reconnect electrical connector to the solenoid.

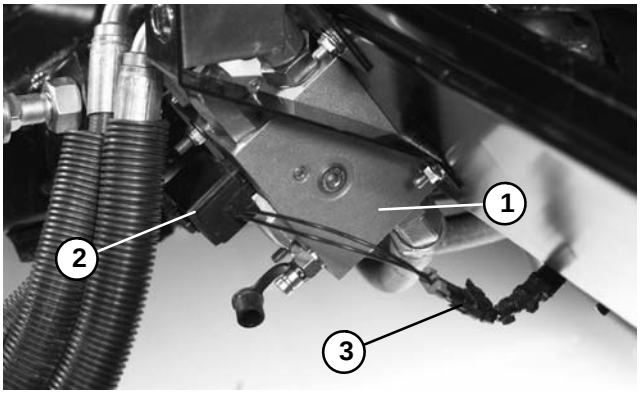

Figure 22

1. **Manifold (RH shown)**
2. **Valve solenoid**
3. **Solenoid connector**

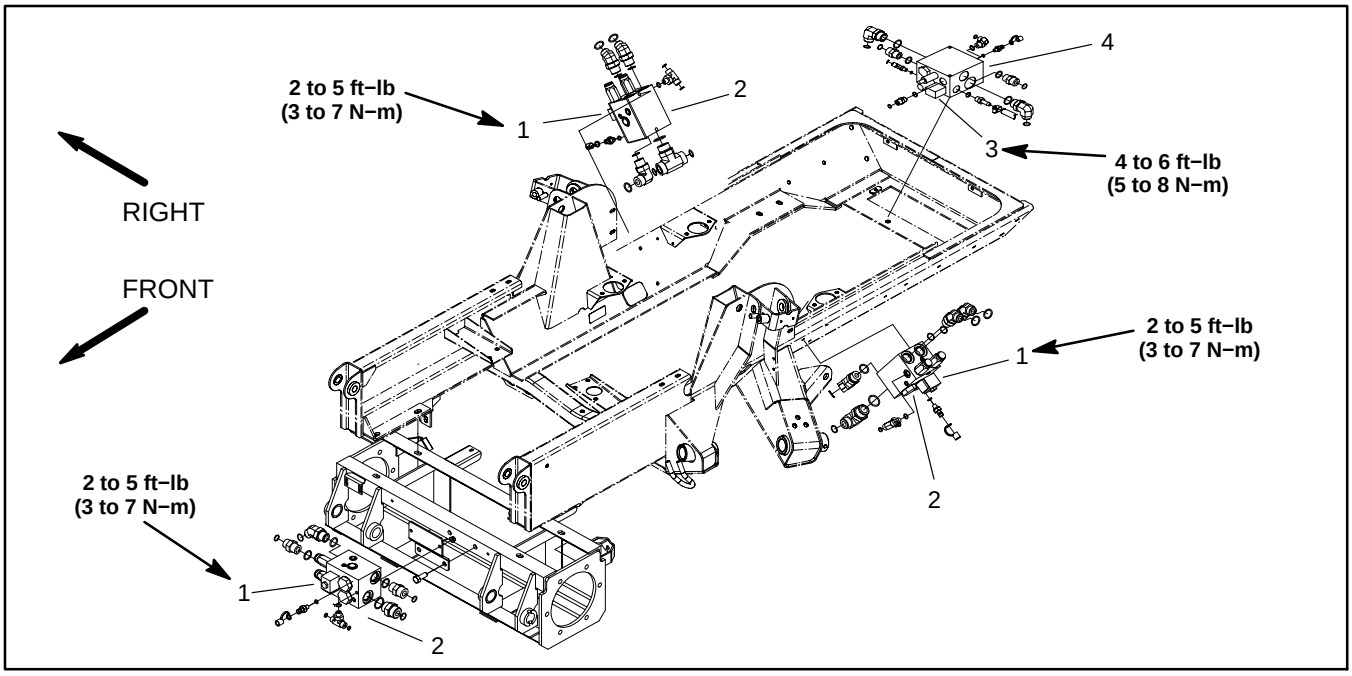

Figure 23

1. **Hydraulic valve solenoid (decks)**
2. **Hydraulic manifold (decks)**
3. **Hydraulic valve solenoid (traction)**
4. **Hydraulic manifold (traction)**

Engine Run Solenoid

The engine run solenoid must be energized for the engine to run. It is mounted on the engine block near the injection pump.

In Place Testing

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Disconnect the connector from the engine run solenoid.

2. Using a digital multimeter, touch one lead to the pin of the black wire and the other lead to the pin of the white wire. The resistance of the pull coil should be about 0.26 ohms.

3. Using a digital multimeter, touch one lead to the pin of the black wire and the other lead to the pin of the red wire. The resistance of the hold coil should be about 10.9 ohms.

4. Connect solenoid to the wiring harness.

Live Testing

1. Disconnect connector from the engine run solenoid.

NOTE: The solenoid may be removed from the engine or tested in place.

2. If the solenoid is removed from the engine, make sure that the solenoid linkage moves freely and is free of dirt, debris, and corrosion.

3. Connect a positive (+) test lead from a 12 VDC source to the pins of the red and white wires.

4. Touch a negative (−) test lead from the 12 VDC source to the pin of the black wire. The solenoid should engage making an audible “click”.

5. Remove positive (+) voltage from the pin of the white wire. The solenoid should stay engaged.

6. Remove positive (+) voltage from the pin of the red wire. The solenoid should release.

7. Reinstall solenoid if removed from engine.

8. Reconnect the harness wire connector to the solenoid.

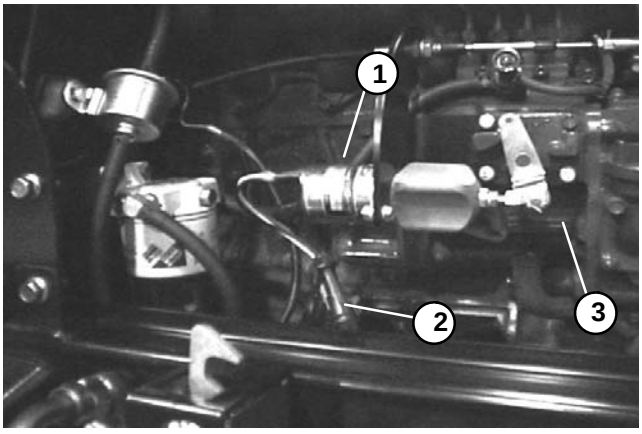

Figure 24

1. **Engine run solenoid**
2. **Solenoid connector**
3. **Injection pump**

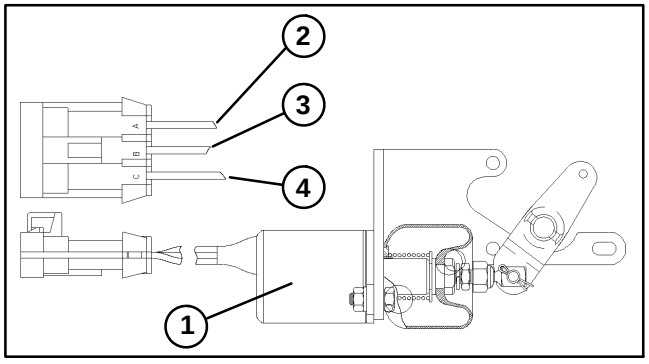

Figure 25

1. **Engine run solenoid**
2. **Red wire (hold coil)**
3. **White wire (pull coil)**
4. **Black wire (common)**

Fuel Sender

The fuel sender is located on top of the fuel tank.

1. Remove white wire and black ground wire from the sender.

2. Remove screws and lock washers that secure the sender to the fuel tank.

3. Remove sender and gasket from the fuel tank. Clean any fuel from the sender.

NOTE: Before taking small resistance readings with a digital multimeter, short meter test leads together. The meter will display a small resistance value. This internal resistance of the meter and test leads should be subtracted from the measured value of the component.

CAUTION

Make sure sending unit is completely dry (no fuel on it) before testing. Perform test away from the tank to prevent an explosion or fire from sparks.

4. Check resistance of the sender with a multimeter.

   A. Resistance with the float in the full position should be 27.5 to 39.5 ohms.

   B. Resistance with the float in the empty position should be 240 to 260 ohms.

5. Replace sender as necessary. Reinstall sender into fuel tank. Connect wires.

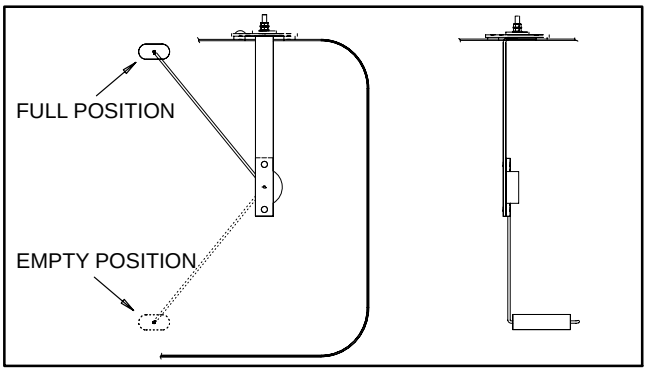

Figure 26

Fuel Gauge

The fuel gauge can be tested using a new gauge as a substitute or with the use of a DC voltage source and a variable resistance box.

CAUTION

Make sure the voltage source is turned OFF before connecting it to the electrical circuit to avoid electrical shock and prevent damaging the gauge.

1. Connect fuel gauge to the variable resistance and DC voltage source (Fig. 27).

NOTE: When reading the gauge test point, there are two white dots on the gauge face below the edge of the glass cover for the each test point. For each variable resistance setting, the needle must be pointed between the two white dots.

2. Take test point readings (Fig. 28).

IMPORTANT: Allow circuit to warm up for at least 5 minutes before taking test readings.

A. Set variable resistance to 240 ohms. Apply a 14 ± 0.01 VDC to the circuit. The needle should point to the left edge of the red area (empty).

B. Set variable resistance to 33 ohms. The needle should point to the right edge of the green area (full).

3. Turn off the voltage source. Disconnect voltage source, gauge, and variable resistance.

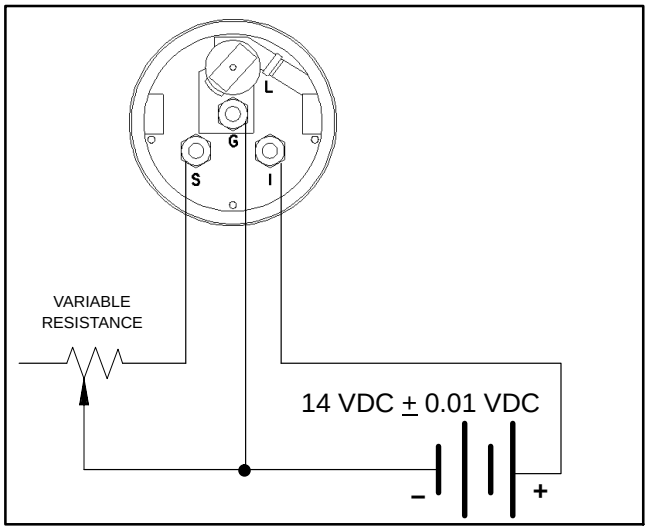

Figure 27

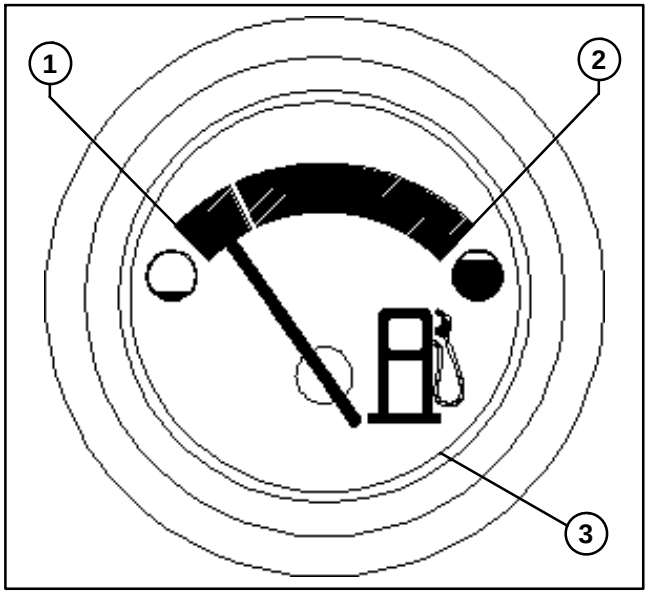

Figure 28

1. **Empty position**
2. **Full position**
3. **Glass face edge**

Fuel Pump

The fuel pump is attached to the frame above the fuel water separator.

Operational Test

1. Park machine on a level surface, lower cutting units, stop engine, and engage parking brake.

2. Disconnect electrical connector from the fuel stop solenoid to prevent the engine from firing.

3. Disconnect fuel hose (pump discharge) from the water separator.

4. Make sure fuel hoses attached to the fuel pump are free of obstructions.

5. Place fuel hose (pump discharge) into a large, graduated cylinder sufficient enough to collect 1 quart (0.95 liter).

6. Collect fuel in the graduated cylinder by turning ignition switch to the ON position. Allow pump to run for 30 seconds, then turn switch to OFF.

7. The amount of fuel collected in the graduated cylinder should be approximately 11.75 fl oz (350 ml) after 30 seconds.

8. Replace fuel pump as necessary. Install fuel hose to the water separator.

9. Reconnect electrical connector to the fuel stop solenoid.

10. Prime fuel system.

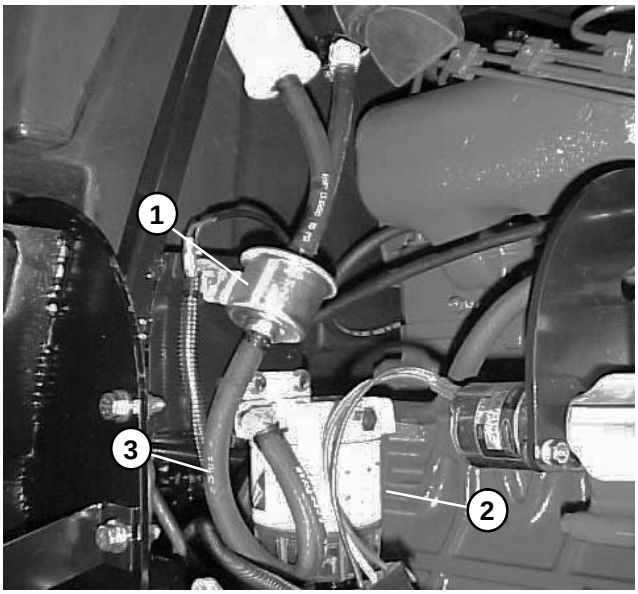

Figure 29

1. **Fuel pump**
2. **Water separator**
3. **Pump discharge hose**

Fuel Pump Specifications

Pump Capacity	23.5 fl oz/min (695 ml/min)
Pressure	3.3 psi (22.8 kPa)
Max. Current Draw	0.9 amp

Glow Controller

The glow controller is located under the console cover.

NOTE: Refer to Chapter 9 − Electrical Schematics and Diagrams when troubleshooting the controller.

Controller Operation

1. When the ignition switch is placed in the ON position, the controller energizes the glow plugs and lights up the glow lamp for 10 seconds.

2. When the ignition switch is held in the START position, the glow plugs will energize and the glow lamp will **not** light.

3. When the ignition switch is released from START to ON, the glow plugs will deenergize and the glow lamp will remain off.

Controller Checks

1. Make sure there is power from the battery.

2. Disconnect electrical connector to the run solenoid to prevent the engine from starting.

3. Place ignition switch in the ON position. Verify the following while in the ON position:

   A. Glow indicator lamp is on.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Glow indicator lamp goes out and glow plugs deenergize after 10 seconds.

4. Place ignition switch in the START position. Verify the following while in the START position:

   A. Glow indicator lamp is out.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Power to terminal 1 of the glow controller.

NOTE: If there is no power to terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the controller and perform step 4 again (see Chapter 9 − Electrical Schematics and Diagrams).

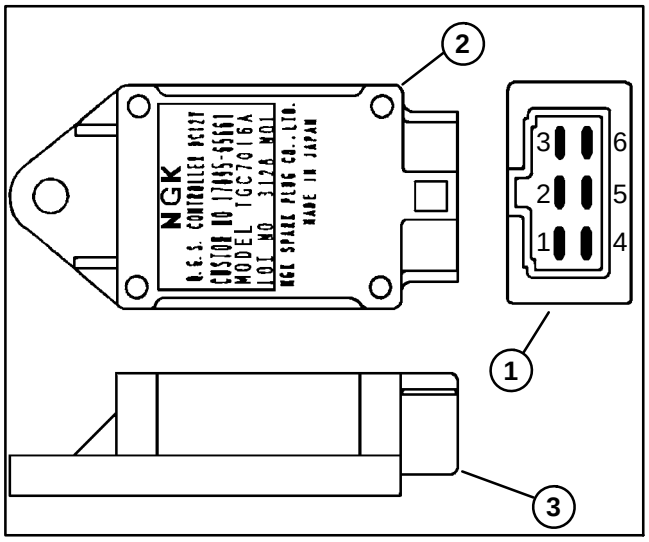

Figure 30

1. Glow controller end view
2. Controller top view
3. Controller side view

5. If any of the conditions in step 3 are not met or power to terminal 1 exists and any of the other conditions in step 4 are not met:

   A. Verify continuity of the circuitry from the battery to the glow relay and glow plugs (see Chapter 9 − Electrical Schematics and Diagrams).

   B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow lamp, glow relay, and ground (see Chapter 9 − Electrical Schematics and Diagrams).

   C. Replace parts as necessary.

6. Connect electrical connector to the run solenoid.

Temperature Sender

The temperature sender is located near the alternator on the water flange attached to the engine cylinder head (Fig. 31). There is a gray wire attached to the terminal of the switch.

1. Lower coolant level in the engine and remove the temperature sender from water flange.

2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 32).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

NOTE: Prior to taking resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

3. Check resistance of the sender with a multimeter (ohms setting) as the temperature increases.

   A. The meter should indicate from 54 to 78 ohms at 200ºF (93.3ºC).

   B. Replace sender if specification is not met.

4. Install sender to the water flange.

   A. Clean threads of water flange and sender thoroughly. Apply thread sealant to the threads of the sender.

   B. Screw sender into the water flange and tighten.

   C. Reconnect gray wire to sender. Apply skin−over grease (Toro Part No. 505−165) to sender terminal.

5. Fill engine cooling system (see Operator's Manual).

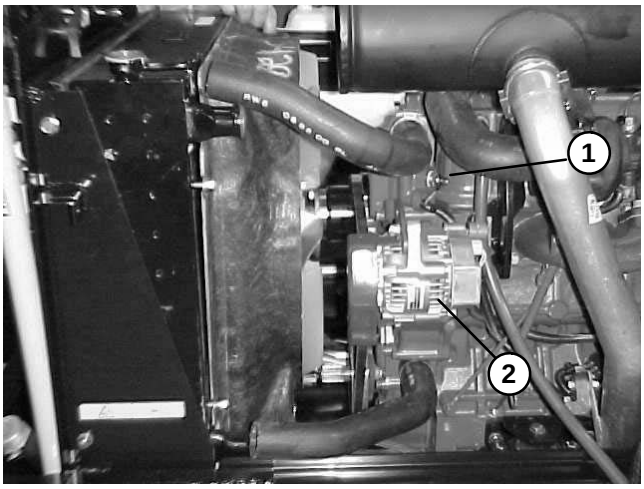

Figure 31

1. Temperature sender **2. Alternator**

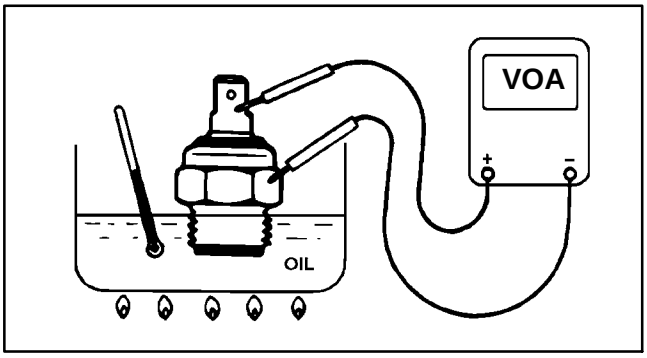

Figure 32

High Temperature Shutdown Switch

The high temperature shutdown switch is located near the glow plug connection on the engine cylinder head (Fig. 33). There is a blue wire attached to the switch.

CAUTION

Make sure engine is cool before removing the temperature switch.

1. Lower coolant level in the engine and remove the temperature shutdown switch.

2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 34).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check continuity of the switch with a multimeter (ohms setting). The temperature switch is normally open and should close between 225° to 235°F (107° to 113°C).

4. Allow oil to cool while observing temperature. The temperature switch should open at about 219°F (104°C).

5. Replace switch if necessary.

6. Install switch to the water flange.

   A. Clean threads of cylinder head and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Screw switch into the cylinder head and tighten.

   C. Connect blue wire to switch.

7. Fill engine cooling system (see Operator's Manual).

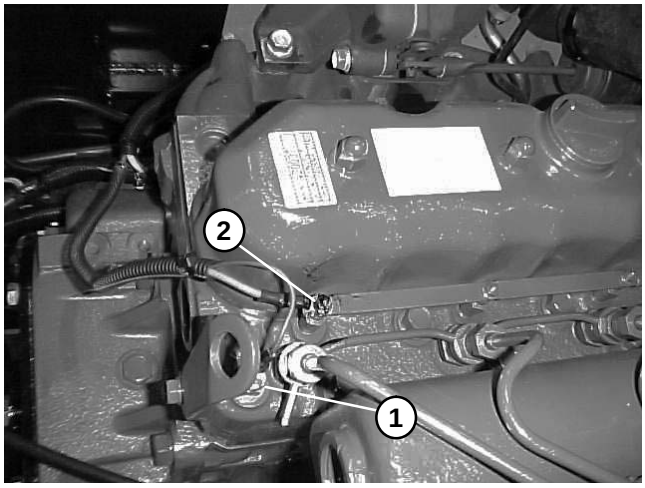

Figure 33

1. Temp. shutdown switch 2. Glow plug connection

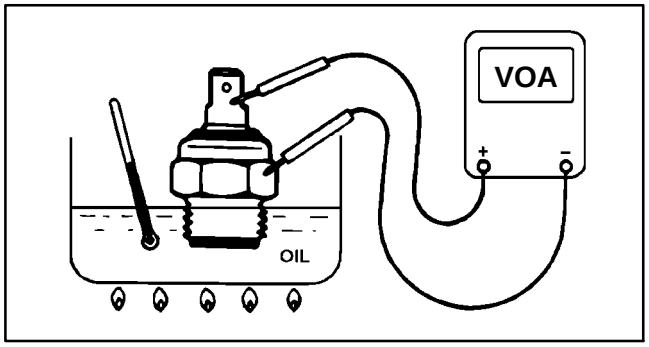

Figure 34

Temperature Gauge

The temperature gauge can be tested using a new gauge as a substitute or by the use of a DC voltage source and a variable resistance box.

CAUTION

Make sure the voltage source is turned OFF before connecting variable resistance to the electrical circuit to avoid electrical shock and to prevent damaging the gauge.

1. Connect temperature gauge to the variable resistance and DC voltage source (Fig. 27).

NOTE: When reading the gauge test point, there are two white dots on the gauge face below the edge of the glass cover for the each test point. For each variable resistance setting, the needle must be pointed between the two white dots.

2. Take test point readings (Fig. 28).

IMPORTANT: Allow circuit to warm up for at least 5 minutes before taking test readings.

A. Set variable resistance to 71 ohms. Apply a 14 ± 0.01 VDC to the circuit. The needle should point to the middle of the green area (80ºC).

B. Set variable resistance to 38 ohms. The needle should point between the green and red area (105ºC).

3. Turn off the voltage source. Disconnect voltage source, gauge, and variable resistance.

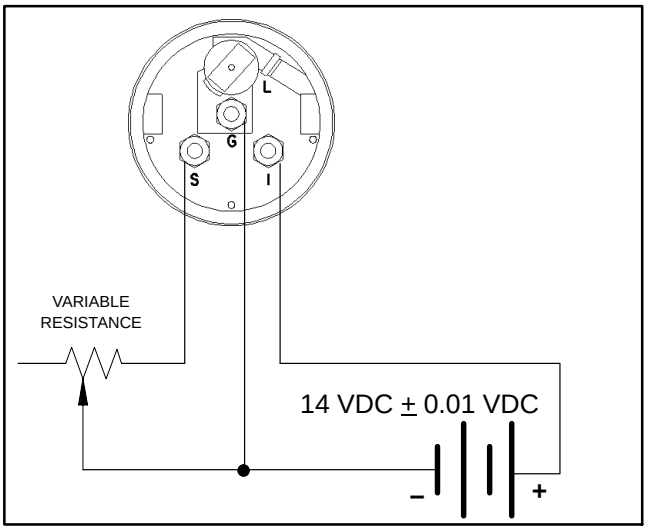

Figure 35

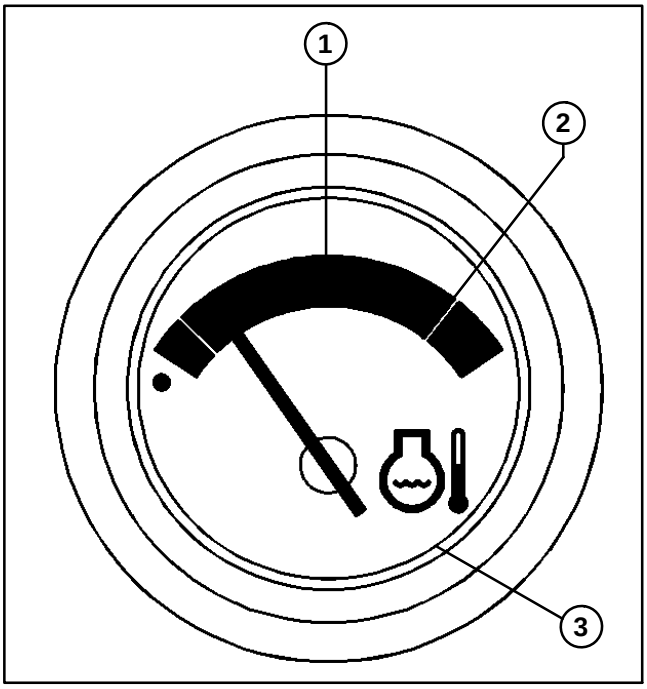

Figure 36

1. **Middle position**
2. **High temp position**
3. **Edge of glass cover**

Traction Neutral Switch

The traction neutral switch is closed when the traction pedal is in the neutral position and opens when the pedal is depressed in either direction. The switch is located on the right side of the piston (traction) pump.

Test the switch by disconnecting the wires from the switch terminals and connecting a continuity tester across the two switch terminals. With the engine turned off, slowly push the traction pedal in a forward or reverse direction while watching the continuity tester. There should be indications that the traction neutral switch is opening and closing. Allow the traction pedal to return to the neutral position. There should be continuity across the switch terminals when the traction pedal is in the neutral position.

See Piston Pump Control Assembly in Chapter 4 − Hydraulic Systems for disassembly and reassembly procedures for the neutral switch.

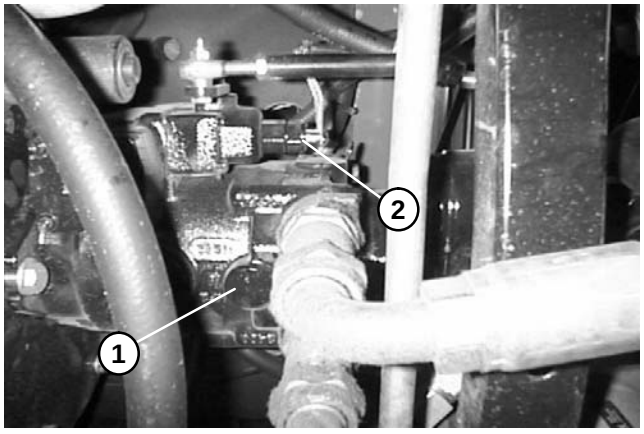

Figure 37

1. **Piston pump (bottom)**
2. **Neutral switch**

Diode Assemblies

The diodes D2, D4, D5, and D6 (Fig. 38) are used for circuit protection that occur when a hydraulic valve solenoid is de−energized. Diode D2 is in the Transport/Mow circuit, D4 is in the left cutting deck circuit, D5 is in the front cutting deck circuit, and D6 is in the right cutting deck circuit. The diodes plug into the wiring harness.

Testing

The diodes can be individually tested using a digital multimeter (diode test or ohms setting) and the table to the right.

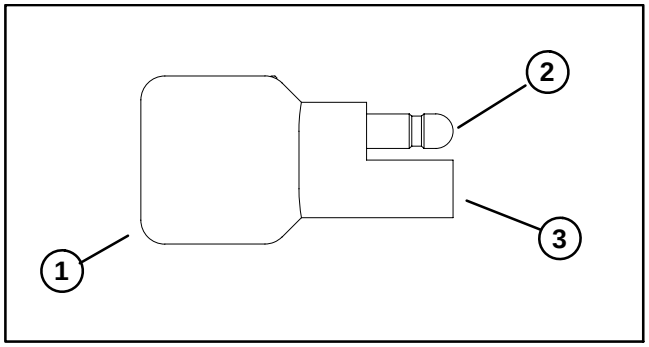

Figure 38

1. **Diode**
2. **Male terminal**
3. **Female terminal**

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (−) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

Diode Circuit Board

The circuit board contains four diodes (Fig. 39) and is located under the console housing. The diodes are used for circuit protection from inductive voltage spikes that occur when a hydraulic valve solenoid is de−energized. Diode D1 is in the left cutting deck circuit, D2 is in the Transport/Mow circuit, D3 is in the front cutting deck circuit, and D4 is in the right cutting deck circuit.

Testing

The diodes can be individually tested using a digital multimeter (ohms setting) and the table to the right. If any of the diodes are damaged, the diode circuit board must be replaced.

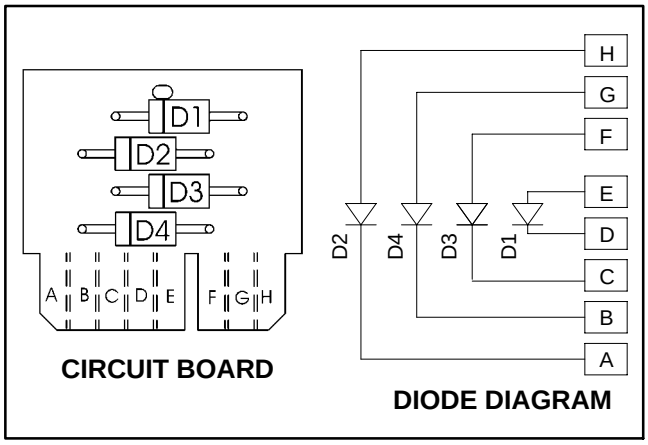

Figure 39

Red Lead (+) on Terminal	Black Lead (−) on Terminal	Continuity
H	A	YES
A	H	NO
G	B	YES
B	G	NO
F	C	YES
C	F	NO
E	D	YES
D	E	NO

Cutting Deck Position Switch

The cutting deck position switches on the Groundsmaster 4000−D are located on the traction unit frame (Fig. 40 and 41) and are normally open. The position switch is a powered proximity switch that incorporates an internal reed switch and relay (see schematic in Figure 42). The sensing plate is located on the cutting deck lift arm. The switches for front and side decks are the same although their operation depends on deck location.

When a side cutting deck is raised, the sensing plate is moved away from the position switch and the switch opens. The open switch prevents current flow to the side deck solenoid and keeps the deck from operating.

When the front cutting deck is raised, the sensing plate is moved near the position switch and the switch closes. The closed switch prevents current flow to the front deck solenoid and keeps the deck from operating.

Testing

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Locate switch that requires testing and disconnect switch connector from machine wiring harness.

3. Ground switch connector terminal for black wire and apply 12 VDC to switch connector terminal for red wire.

4. Using a multimeter, verify that switch connector terminal for blue wire has 12 VDC and terminal for white wire has 0 VDC.

5. Place metal object near sensing area of switch (opposite end from wires). Ground switch connector terminal for black wire and apply 12 VDC to switch connector terminal for red wire.

6. Using a multimeter, verify that switch connector terminal for blue wire has 0 VDC and terminal for white wire has 12 VDC.

7. Replace switch as needed.

Adjustment

NOTE: Deck Proximity Switch Adjustment Tool (TOR4095) can be used for switch adjustment.

1. Sensing plate on side deck lift arms should be 0.060” to 0.120” (1.5 to 3.0 mm) from target surface of position switch.

2. On front deck lift arm, slide sensing plate as far from the lift arm as possible.

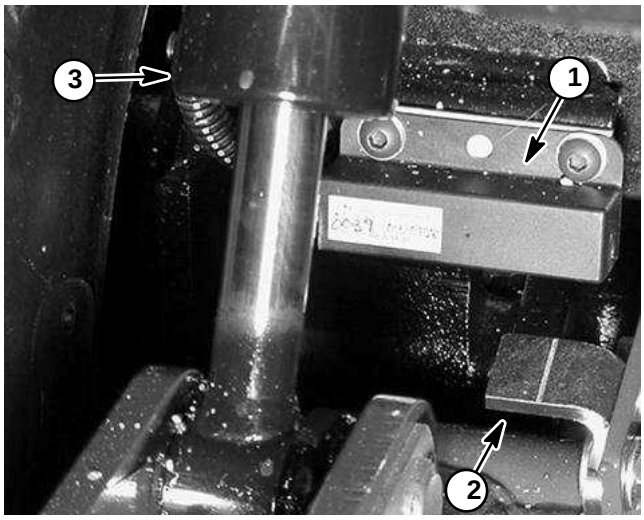

Figure 40

1. **Position switch (front)**
2. **Sensing plate**
3. **Front lift cylinder**

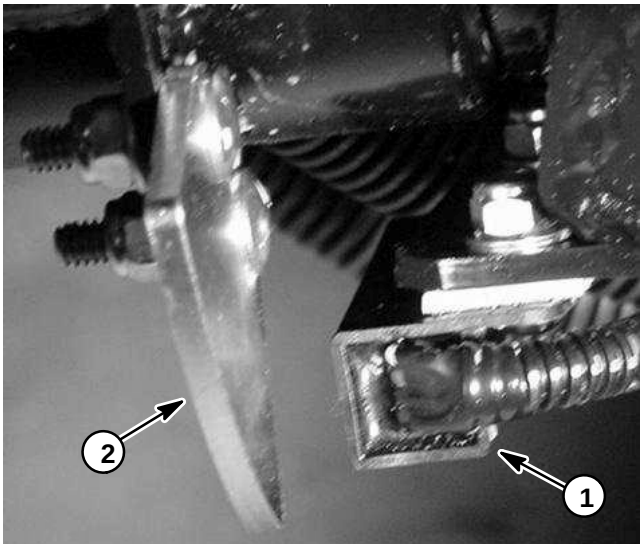

Figure 41

1. **Position switch (side)**
2. **Sensing plate**

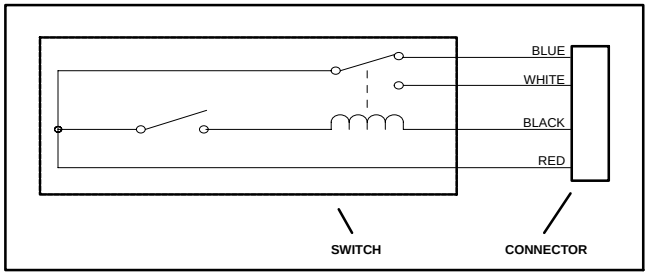

Figure 42

Service and Repairs

NOTE: For more component repair information, see the Kubota Workshop Manual, Diesel Engine, V2003−T Series at the end of Chapter 3 − Kubota Diesel Engine.

Battery Storage

If the machine will be stored for more than 30 days:

1. Remove the battery and charge it fully (see Battery Service).

2. Either store battery on a shelf or on the machine.

3. Leave cables disconnected if the battery is stored on the machine.

4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.

5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service).

Battery Care

1. Battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will run down more rapidly than if the machine is stored in a location where temperatures are cool.

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gasses produced while charging can dissipate. Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT: Do not remove fill caps while cleaning.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

   B. Coat battery posts and cable connectors with skin−over grease (Toro Part No. 505−165) or petroleum jelly to prevent corrosion.

3. Battery cables must be tight on terminals to provide good electrical contact.

WARNING

Connecting cables to the wrong post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (−) cable first. Clean clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with skin−over grease (Toro Part No. 505−165) or petroleum jelly to prevent corrosion.

5. Check electrolyte level every 25 operating hours, and every 30 days if machine is in storage.

6. Maintain cell level with distilled or demineralized water. Do not fill cells above the fill line.

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Electrolyte Specific Gravity
Fully charged: 1.265 corrected to 80ºF (26.7ºC)
Discharged: less than 1.240

Battery Specifications
BCI Group Size 24
650 CCA at 0º F (−17.8º C)
Reserve Capacity of 110 minutes at 80ºF (26.7ºC)

Dimensions (including terminal posts and caps)

Length	10.2 inches (25.9 cm)
Width	6.64 inches (16.9 cm)
Height	8.99 inches (22.8 cm)

Removal and Installation (Fig. 43)

See Operator's Manual for battery removal and installation information.

NOTE: Before connecting the negative (ground) cable, connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the unit's electrical system should be tested and repaired.

Inspection, Maintenance, and Testing

1. Perform following inspections and maintenance:

   A. Check for cracks. Replace battery if cracked or leaking.

   B. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

   C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post, or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

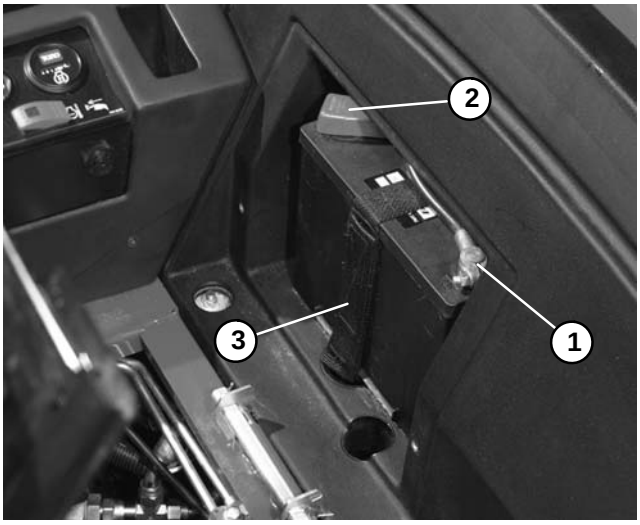

Figure 43

1. **Negative cable**
2. **Positive cable**
3. **Battery retainer**

   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water between the minimum and maximum fill lines. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

   A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm−up the hydrometer. At the same time take the temperature of the cell.

   B. Temperature correct each cell reading. For each 10ºF (5.5ºC) above 80ºF (26.7ºC) add 0.004 to the specific gravity reading. For each 10ºF (5.5ºC) below 80ºF (26.7ºC) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature	100ºF
Cell Gravity	1.245
100ºF minus 80ºF equals 20ºF	
(37.7ºC minus 26.7ºC equals 11.0ºC)	
20ºF multiply by 0.004/10ºF equals 0.008	
(11ºC multiply by 0.004/5.5ºC equals 0.008)	
ADD (conversion above)	0.008
Correction to 80ºF (26.7ºC)	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

3. Perform a high−discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold−cranking test. A commercial battery load tester is **required** to perform this test.

CAUTION

Follow the manufacturer's instructions when using a battery tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure battery terminals are free of corrosion.

D. Measure the temperature of the center cell.

E. Connect a battery load tester to the battery terminals **following the manufacturer's instructions**. Connect a digital multimeter to the battery terminals.

F. Apply a test load of one half the Cranking Performance (see Battery Specifications) rating of the battery for 15 seconds.

G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading:

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	−1.1°C
8.9	20°F	−6.7°C
8.7	10°F	−12.2°C
8.5	0°F	−17.8°C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most shops.

CAUTION

Follow the manufacturer's instructions when using a battery charger.

NOTE: Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	**5.3 hrs @ 4 amps**	**10.5 hrs @ 4 amps**	**15.8 hrs @ 4 amps**	**21 hrs @ 4 amps**
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (15.5° C) before connecting to a charger.

Charge the battery in a well−ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the manufacturer's instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (51.6°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three consecutive readings.

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Chapter 6

Axles, Planetaries, and Brakes

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Specifications

Item	Specification
Wheel lug nut torque	85 to 100 ft−lb (115 to 135 N−m), front and rear
Steering cylinder bolt torque	100 to 125 ft−lb (139 to 169 N−m)
Rear wheel toe−in	.125 in (3.18 mm)
Tire pressure	25 to 30 psi (1.7 to 2.1 bar), front and rear
Planetary brake housing and wheel motor mounting screw torque	75 to 85 ft−lb (101 to 115 N−m)
Planetary gear drive oil System gear lube capacity (each wheel)	SAE 85W−140 wt. gear lube 16 fl oz (.47 l)
Rear axle lubricant System gear lube capacity	SAE 85W−140 wt. gear lube 80 fl oz (2.37 l)
Rear axle gear box lubricant System gear lube capacity	SAE 85W−140 wt. gear lube 16 fl oz (.47 l)

Adjustments

See Operator's Manual for adjustment procedures for Groundsmaster 4000−D axles, planetaries, and brakes.

Brake Assembly

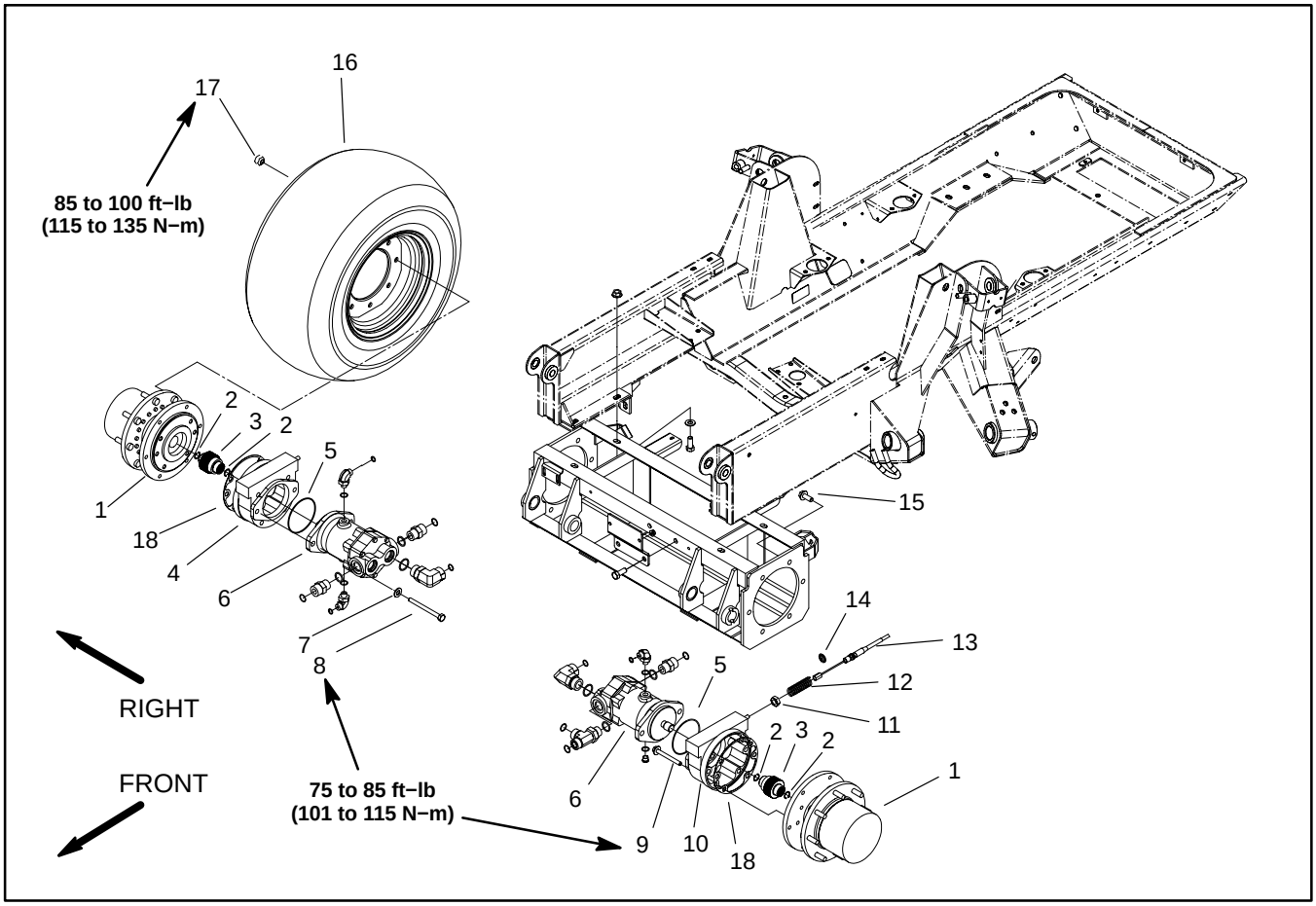

Figure 1

1. **Planetary assembly**
2. **Retaining ring**
3. **Splined brake shaft**
4. **Brake assembly (RH)**
5. **O−ring**
6. **Hydraulic wheel motor**
7. **Flat washer**
8. **Cap screw**
9. **Flange head screw**
10. **Brake assembly (LH)**
11. **Jam nut**
12. **Compression spring**
13. **Brake cable**
14. **Spring plate**
15. **Flange head screw**
16. **Tire and wheel assembly**
17. **Lug nut**
18. **Gasket**

Remove Brake Assembly (Fig. 1)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Drain oil from planetary wheel drive/brake assembly (see Operator's Manual).

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 − Safety). Support machine with jack stands or solid wood blocks.

4. Remove wheel assembly.

5. Remove hydraulic wheel motor (see Front Wheel Motors in Service and Repairs section of Chapter 4 − Hydraulic System).

6. Disconnect brake cable from pull rod on brake.

7. Remove flange head capscrews (5) securing brake assembly to frame; be careful not to drop splined brake shaft as brake assembly is removed.

8. Remove splined brake shaft.

9. Complete brake inspection and repair.

Install Brake Assembly (Fig. 1)

1. Install splined brake shaft into brake assembly. **Note:** The stepped end of the splined brake shaft must be aligned toward the hydraulic wheel motor (Fig. 2).

2. Install brake assembly onto frame, aligning splined brake shaft with input shaft on planetary wheel drive.

3. Install flange head screws (5) to secure brake assembly to frame. Tighten screws in a crossing pattern to a torque from 75 to 85 ft−lb (101 to 115 N−m).

4. Install brake cable to pull rod on brake assembly. Brake cable end should be completely threaded onto pull rod.

5. Install new o−ring on hydraulic wheel motor. Install wheel motor and torque capscrews from 75 to 85 ft−lb (101 to 115 N−m).

WARNING

Failure to maintain proper torque could result in failure or loss of wheel and may result in personal injury.

6. Install wheel assembly. Torque lug nuts from 85 to 100 ft−lb (115 to 135 N−m).

7. Lower machine to ground.

8. Make sure drain plug is installed in bottom of brake assembly (Fig. 3). Fill planetary wheel drive/brake assembly with SAE 85W−140 gear lube (see Operator's Manual). Capacity is approximately 16 oz. (.47 l) per wheel.

9. Check and adjust brake cables for proper brake operation (see Operator's Manual).

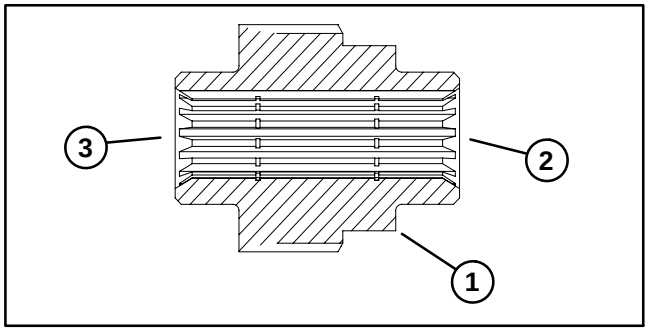

Figure 2

1. **Splined brake shaft step**
2. **Hydraulic motor end**
3. **Planetary assembly end**

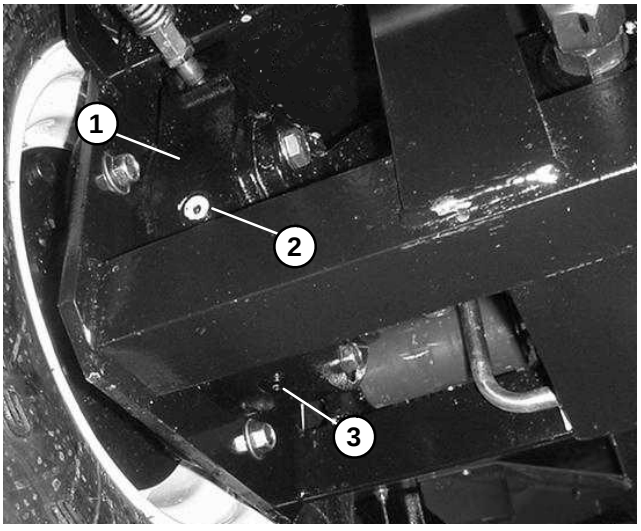

Figure 3

1. **Brake housing**
2. **Check plug**
3. **Drain plug**

Brake Inspection and Repair

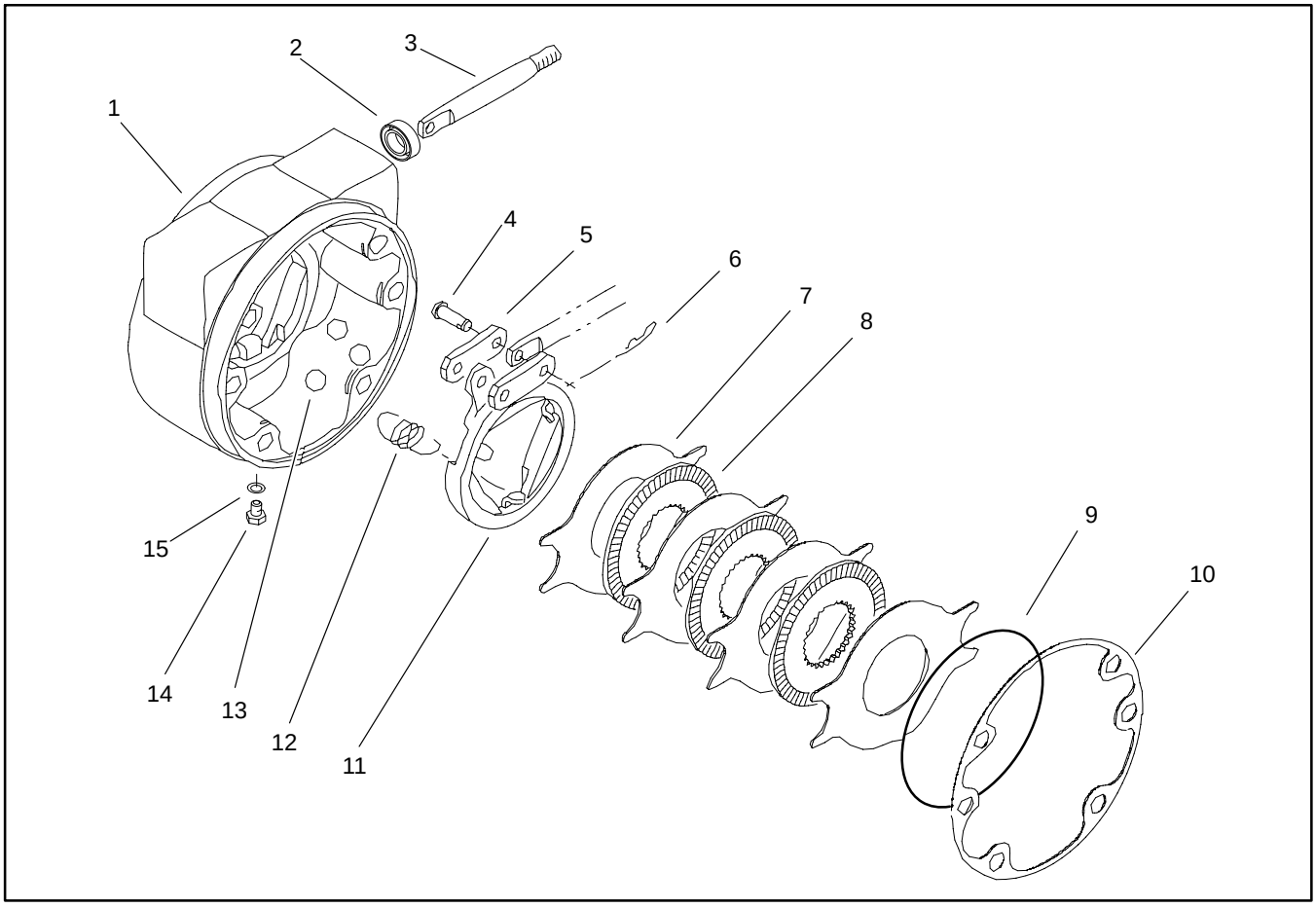

Figure 4

1. **Brake housing (LH shown)**
2. **Seal**
3. **Pull rod**
4. **Clevis pin**
5. **Link**
6. **Hitch pin**
7. **Stationary disc**
8. **Rotating disc**
9. **Retaining ring**
10. **Gasket**
11. **Rotating actuator**
12. **Extension spring**
13. **Ball**
14. **Plug**
15. **O−ring**

Brake Inspection and Repair (Fig. 4)

1. Scrape gasket material (10) from brake housing and planetary wheel drive mounting surfaces.

2. Remove retaining ring (9).

3. Remove stationary discs (7) and rotating discs (8).

4. Remove extension springs (12).

5. Remove actuator assembly (11, 6, 5, 4, 3) and balls (13).

6. Remove seal (2) from brake housing.

7. Wash parts in cleaning solvent. Inspect components for wear or damage.

8. Reverse steps 2 − 6 to assemble brakes, installing new parts as necessary. Install a new seal (2).

9. Use a new gasket (10) when installing brake assembly to machine.

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Planetary Wheel Drive Assembly

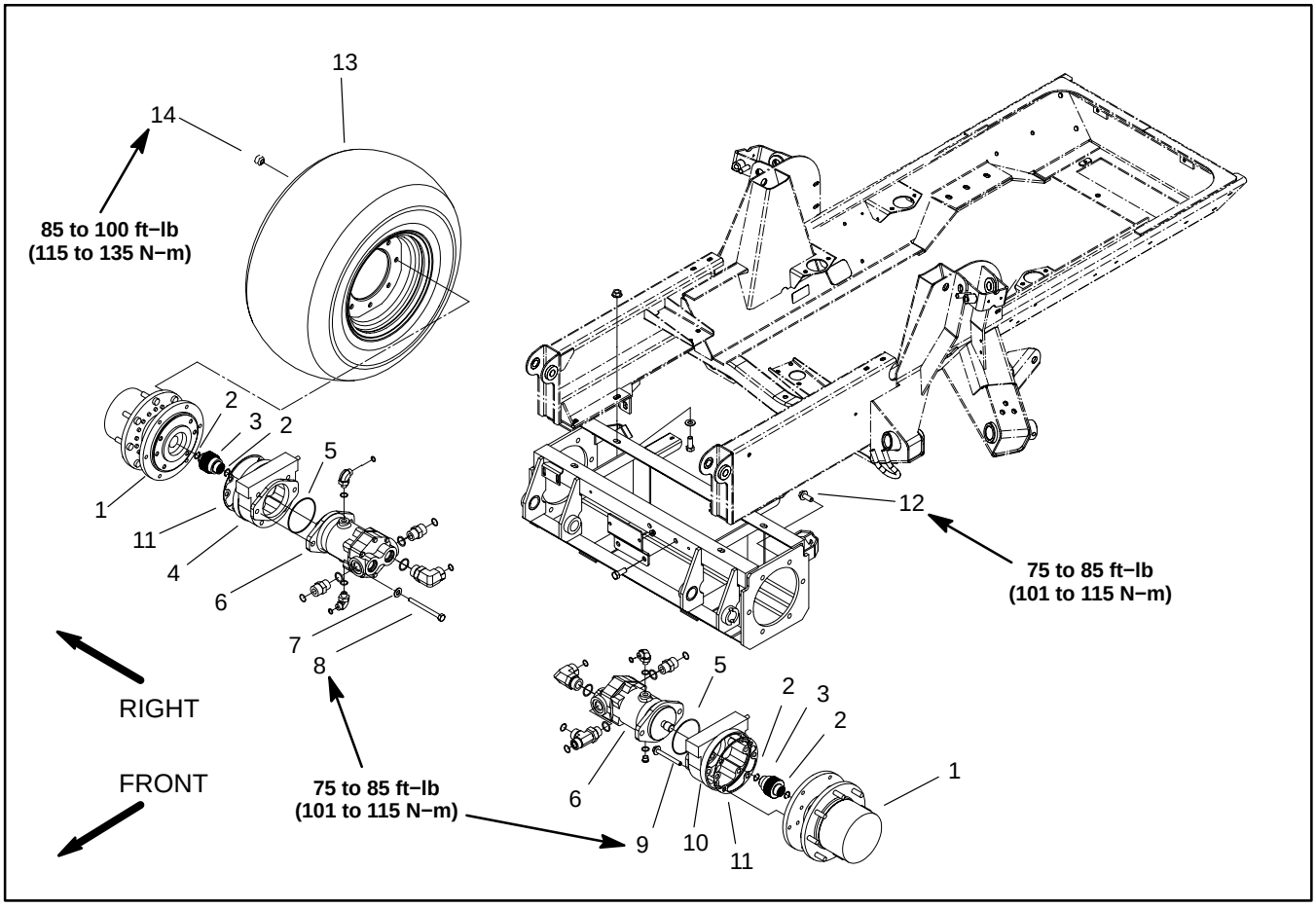

Figure 5

1. **Planetary assembly**
2. **Retaining ring**
3. **Splined brake shaft**
4. **Brake assembly (RH)**
5. **O−ring**
6. **Hydraulic wheel motor**
7. **Flat washer**
8. **Cap screw**
9. **Flange head screw**
10. **Brake assembly (LH)**
11. **Gasket**
12. **Flange head screw**
13. **Tire and wheel assembly**
14. **Lug nut**

Planetary Wheel Drive Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Drain oil from planetary wheel drive/brake assembly (see Operator's Manual).

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 − Safety). Support machine with jack stands or solid wood blocks.

4. Remove front wheel assembly.

5. Remove hydraulic wheel motor (see Front Wheel Motors in Service and Repairs section of Chapter 4 − Hydraulic System).

6. Remove brake assembly (see Brake Assembly).

7. Support planetary assembly to prevent it from falling. Loosen and remove flange head screws that secure planetary assembly to frame. Remove planetary assembly from machine.

Planetary Wheel Drive Installation

1. Position planetary assembly to machine. Install flange head screws that secure planetary assembly. Torque screws from 75 to 85 ft−lb (101 to 115 N−m).

2. Install brake assembly (see Brake Assembly).

3. Install hydraulic wheel motor (see Front Wheel Motors in Service and Repairs section of Chapter 4 − Hydraulic System).

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

4. Install wheel assembly. Torque lug nuts from 85 to 100 ft−lb (115 to 135 N−m).

5. Lower machine from jack stands.

6. Make sure drain plug is installed in bottom of brake assembly (Fig. 6). Fill planetary wheel drive/brake assembly with SAE 85W−140 gear lube (see Operator's Manual). Capacity is approximately 16 oz. (.47 l) per wheel.

7. Check and adjust brake cables for proper brake operation (see Operator's Manual).

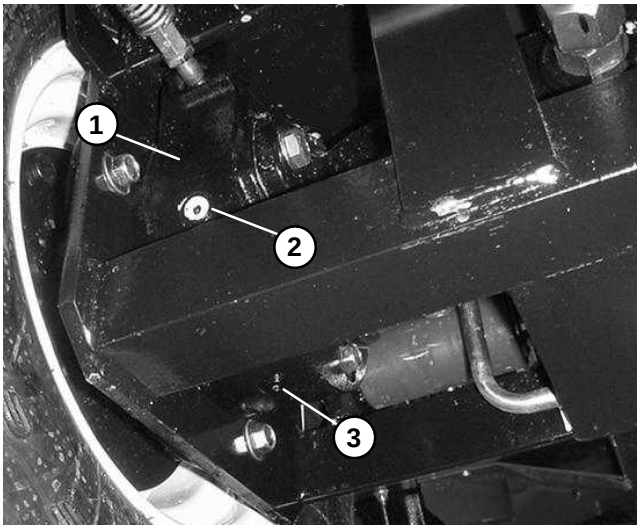

Figure 6

1. **Brake housing**
2. **Check plug**
3. **Drain plug**

Planetary Wheel Drive Service

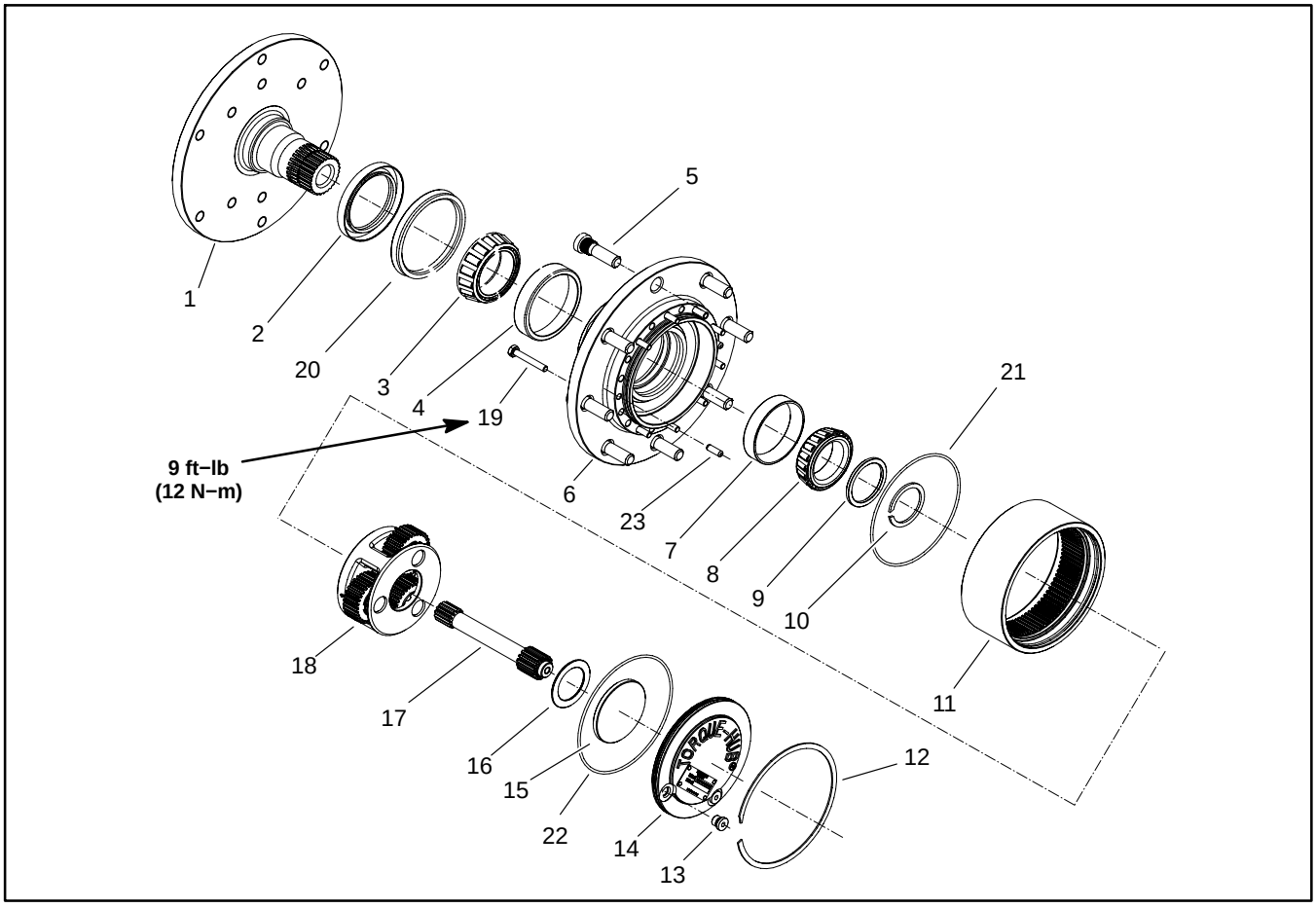

Figure 7

1. **Spindle**
2. **Seal**
3. **Bearing cone**
4. **Bearing cup**
5. **Wheel stud**
6. **Housing**
7. **Bearing cup**
8. **Bearing cone**
9. **Thrust washer**
10. **Retaining ring (external)**
11. **Ring gear**
12. **Retaining ring (internal)**
13. **Plug**
14. **Cover plate**
15. **Input spacer**
16. **Thrust washer**
17. **Input shaft**
18. **Carrier assembly**
19. **Cap screw**
20. **Seal**
21. **O−ring**
22. **O−ring**
23. **Dowel pin**

Planetary Wheel Drive Disassembly (Figure 7)

1. Remove retaining ring (12).

2. Remove cover plate (14).

3. Remove input spacer (15) and thrust washer (16).

4. Remove input shaft (17).

5. Remove carrier assembly (18).

NOTE: Steps 6 −10 are necessary only if inspecting or replacing bearings and/or seals.

6. Remove cap screws (19) and remove ring gear (11).

7. Remove retaining ring (10) and thrust washer (9).

8. Use a puller to remove spindle (1) from housing (6). Remove bearing cone (8).

9. Remove and discard all seals.

10. If bearings will be replaced, use a puller to remove bearing cone (3) from spindle. Remove bearing cups (4 and 7) from housing (6).

Planetary Wheel Drive Assembly (Figure 7)

NOTE: Use new seal kit when assembling planetary wheel drive.

1. Clean parts in solvent. Inspect parts for damage or excessive wear and replace as necessary.

2. Install lip seal (2) to spindle (1).

3. Press bearing cups (4 and 7) into housing (6).

4. Press bearing cone (3) onto spindle (1).

5. Install seal (20) to housing (6). Assemble housing (6) to spindle (1).

6. Press bearing cone (8) onto spindle and secure with thrust washer (9) and retaining ring (10).

7. Install o−ring (21), then assemble ring gear (11) to housing (6) with cap screws (19). Torque cap screws to 9 ft−lb (12 N−m).

8. Install carrier assembly (18).

9. Install input shaft (17).

10. Install thrust washer (16) and input spacer (15).

11. Install o−ring (22), then install cover plate (14). Secure cover with retaining ring (12).

12. Check operation of planetary wheel drive before installing assembly on the machine. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

Rear Axle Assembly

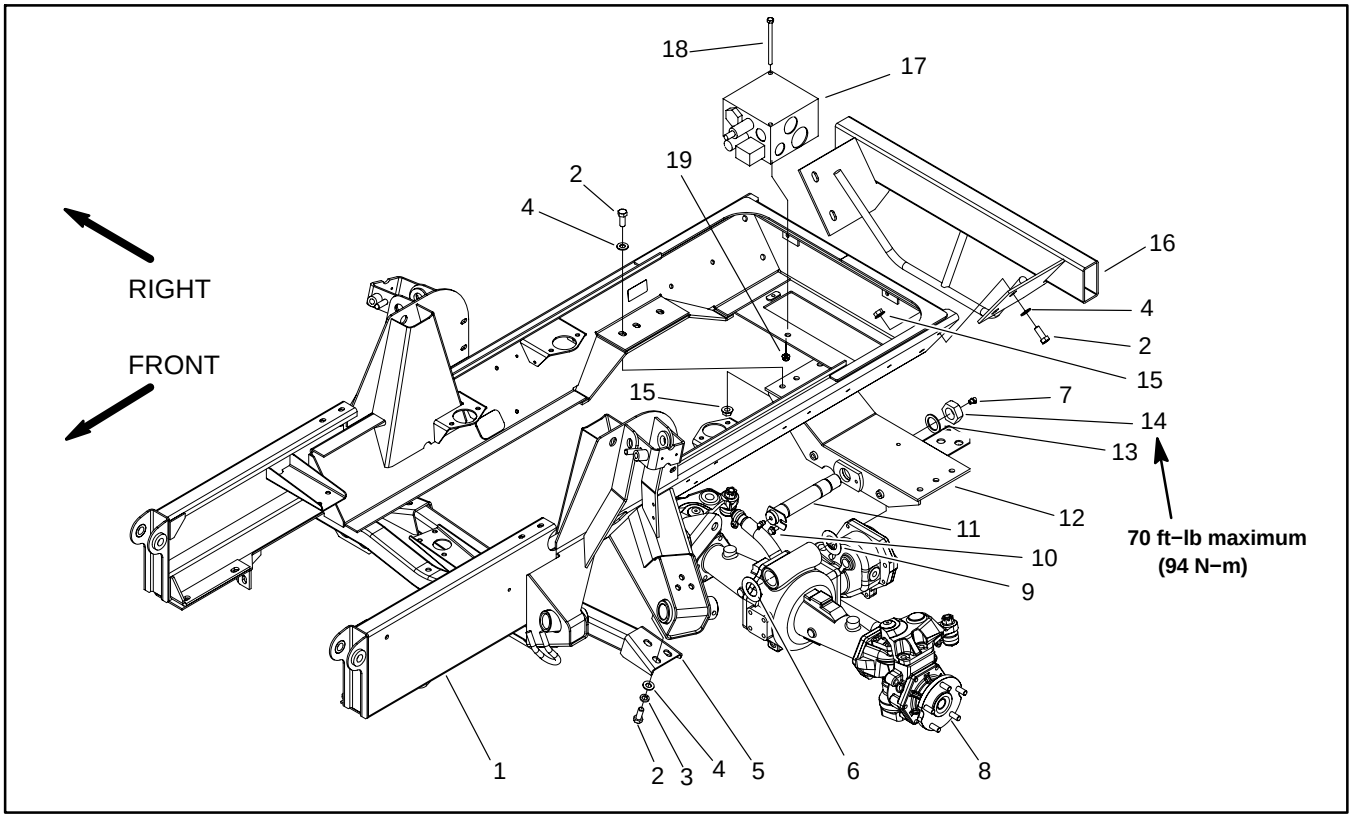

Figure 8

1. **Frame assembly**
2. **Cap screw**
3. **Lock washer**
4. **Flat washer**
5. **Support frame**
6. **Thrust washer (thick)**
7. **Grease fitting**
8. **Rear axle assembly**
9. **Thrust washer (thin)**
10. **Washer head screw**
11. **Pivot pin**
12. **Rear frame mount**
13. **Washer**
14. **Lock nut**
15. **Flange nut**
16. **Rear bumper**
17. **Hydraulic manifold (4WD)**
18. **Cap screw**
19. **Flange nut**

Remove Rear Axle

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

2. Chock front wheels and jack up rear of machine (see Jacking Instructions in Chapter 1 − Safety). Support machine with jack stands or solid wood blocks.

3. Drain oil from rear axle and axle gearbox (see Operator's Manual).

4. Remove wheels from rear axle.

5. Remove hydraulic motor from rear axle assembly (see Rear Axle Motor in Service and Repairs section of Chapter 4 − Hydraulic System).

6. Remove steering cylinder from rear axle (see Steering Cylinder in Service and Repairs section of Chapter 4 − Hydraulic System).

7. Disconnect both steering cylinder hydraulic hoses from hydraulic tubes at rear frame mount (Fig. 9). Remove bulkhead locknuts that secure steering cylinder hydraulic tubes to rear frame mount. Separate tubes from frame mount.

8. Remove cap screw and flange nut that secures front corner of 4WD hydraulic manifold to rear frame mount.

9. If required, remove tie rod ends from steering arms on rear axle (Fig. 10). Remove the cotter pins and castle nuts from the tie rod ball joints. Use a ball joint fork and remove the tie rod ends from the axle steering arms.

10. Support rear axle to prevent it from falling. Remove six cap screws, flat washers, and flange nuts that secure rear frame mount to equipment frame. Lower rear axle and rear frame mount from machine.

11. Remove lock nut and washer from pivot pin that attaches rear axle to rear frame mount. Remove washer head screw that secures flange of pivot pin to frame mount (Fig. 11).

12. Remove pivot pin. Separate rear frame mount from rear axle. Note location of thrust washers on both ends of axle mounting boss.

Install Rear Axle

1. Position rear frame mount to axle. Install thrust washers between axle boss and frame mount. The thinner thrust washer should be installed on the hydraulic motor end of the axle (toward the rear of the machine). With washers installed, there should be .002" to .020" (.05 mm to .51 mm) clearance between rear frame mount and axle mounting boss. Add thrust washers if needed to adjust clearance.

2. Install axle pivot pin to secure axle to rear frame mount. Install washer and lock nut onto pivot pin. Lock nut should be tightened enough to allow pivot pin to rotate (maximum 70 ft−lb (94 N−m)). Secure pivot pin with washer head screw (Fig. 11).

3. If removed, install the tie rod to rear axle (Fig. 10). Tighten ball joint castle nuts and install new cotter pins.

4. Position axle and rear mount under machine with a jack. Raise assembly to machine frame and align mounting holes of rear mount and machine frame.

5. Secure rear mount to frame with six cap screws, flat washers, and flange nuts.

6. Install cap screw and flange nut that secures front corner of 4WD hydraulic manifold to rear frame mount.

7. If removed, install the tie rod to rear axle. Tighten ball joint castle nuts and install new cotter pins.

8. Attach steering cylinder hydraulic tubes to rear frame mount with washers and bulkhead locknuts (Fig. 9). Install steering cylinder hoses to hydraulic tubes.

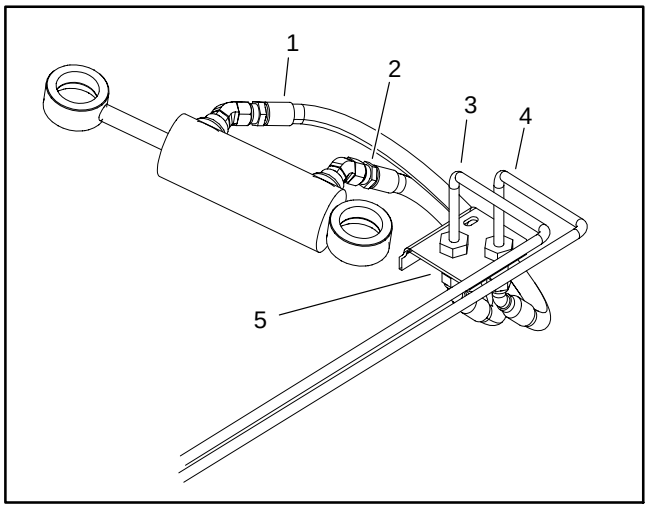

Figure 9

1. **Hydraulic hose**
2. **Hydraulic hose**
3. **Hydraulic tube**
4. **Hydraulic tube**
5. **Rear frame mount**

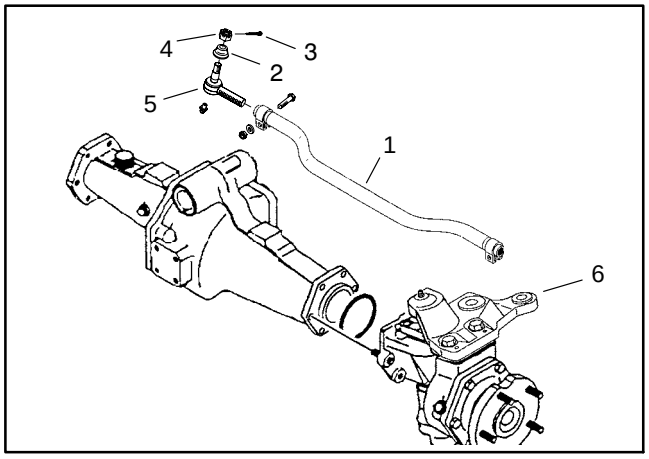

Figure 10

1. **Tie rod**
2. **Dust cover**
3. **Cotter pin**
4. **Castle nut**
5. **Tie rod end**
6. **Steering arm (LH)**

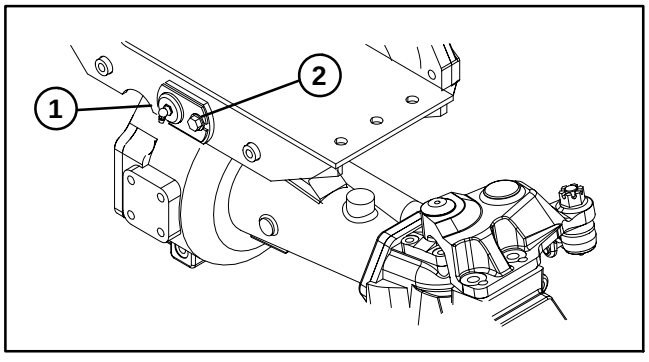

Figure 11

1. **Pivot pin**
2. **Washer head screw**

9. Install steering cylinder to axle assembly (see Steering Cylinder in Service and Repairs section of Chapter 4 − Hydraulic System).

10. Install hydraulic motor to axle assembly (see Rear Axle Motor in Service and Repairs section of Chapter 4 − Hydraulic System).

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

11. Install wheels to axle. Torque wheel lug nuts from 85 to 100 ft−lb (115 to 135 N−m).

12. Lower machine to ground.

13. Fill axle with SAE 85W−140 weight gear lube (see Operator's Manual). Lubricant capacity is approximately 80 fl oz (2.37 l) for the axle and 16 fl oz (.47 l) for the gearbox.

14. Check rear wheel toe−in and adjust if necessary (see Operator's Manual).

15. Check steering stop bolt adjustment. When the steering cylinder is fully extended (right turn), a gap of 1/16" (1.6 mm) should exist between bevel gear case casting and stop bolt on left axle case. Figure 12 shows stop bolt location.

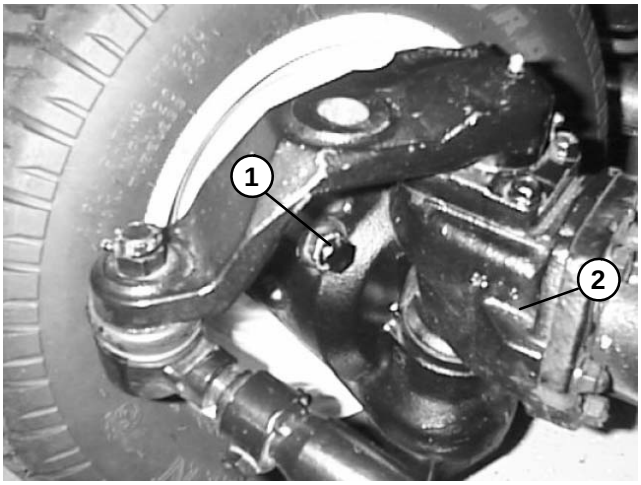

Figure 12

1. **Steering stop bolt**
2. **Bevel gear case (LH)**

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 13).

2. Mark both right and left bevel gear case/axle case assemblies.

IMPORTANT: Do not interchange right and left bevel gear case/axle case assemblies.

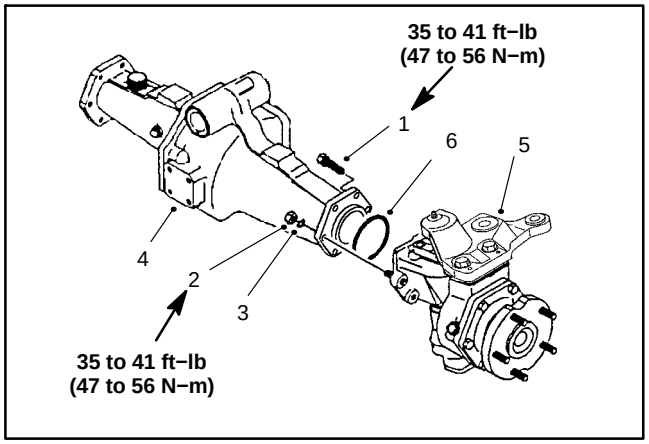

Figure 13

1. Cap screw
2. Lock nut
3. Lock washer
4. Axle support
5. Bevel gear case/axle case assembly
6. O-ring

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 14).

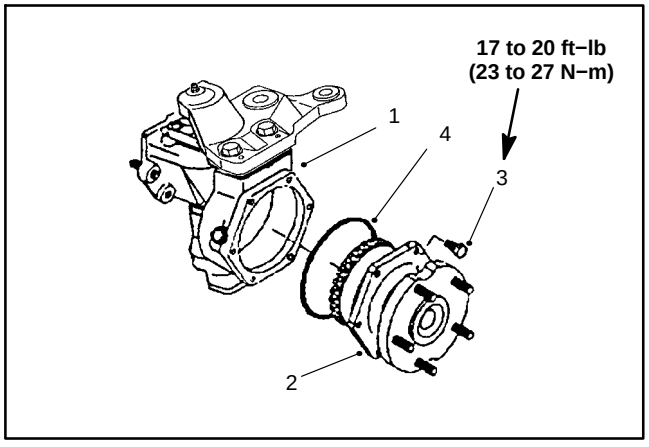

Figure 14

1. Axle case
2. Axle cover assembly
3. Mounting screw
4. O-ring

4. Remove the axle case support mounting screws, the axle case support, and the support shims (Fig. 15).

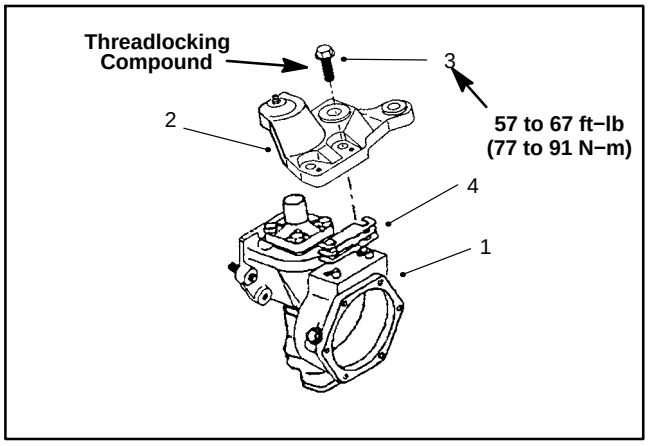

Figure 15

1. Axle case
2. Axle case support
3. Mounting screw
4. Support shim

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Fig. 16).

6. While holding the bevel gear case, tap the upper end of the bevel gear shaft out of the upper bearing and upper bevel gear.

7. Pull the bevel gear case from the axle case and remove the upper bevel gear, and collar from the gear case.

8. Remove the axle case cover screws, cover, and the O-ring from the axle case.

9. Remove the plug and sealing washer from the center of the axle case cover. While holding the axle case cover, lightly tap the lower end of the bevel gear shaft out of the lower bearing and lower bevel gear.

10. Remove and discard bevel gear shaft seal from axle case (Fig. 16).

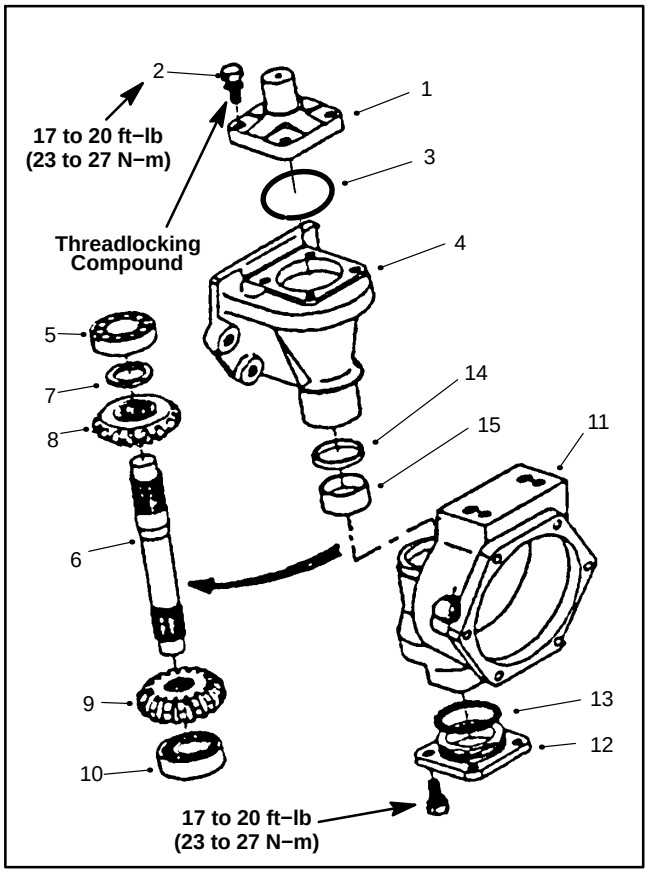

Figure 16

1. **Knuckle pin**
2. **Mounting screw**
3. **O−ring**
4. **Bevel gear case**
5. **Upper bearing**
6. **Bevel gear shaft**
7. **Collar**
8. **Upper bevel gear**
9. **Lower bevel gear**
10. **Lower bearing**
11. **Axle case**
12. **Axle case cover**
13. **O-ring**
14. **Shaft seal**
15. **Bushing**

Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 17). Replace components as necessary.

BUSHING TO PIN CLEARANCE:
0.002 to 0.016 in. (0.05 to 0.40 mm)

KNUCKLE PIN O.D. (Factory Spec.):
0.982 to 0.983 in. (24.95 to 24.98 mm)

AXLE CASE SUPPORT BUSHING I.D.
(Factory Spec.):
0.984 to 0.987 in. (25.00 to 25.08 mm)

2. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

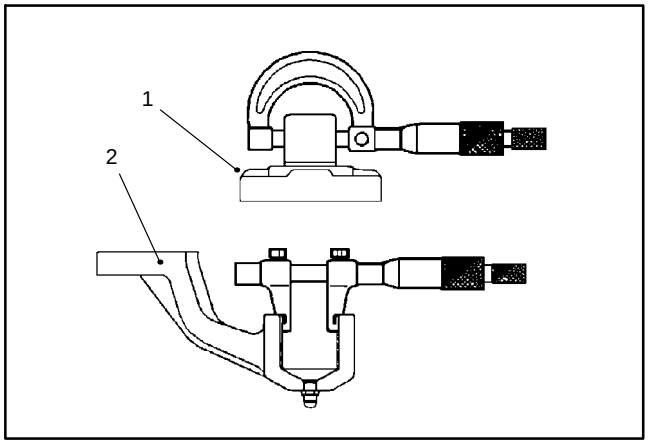

Figure 17

1. **Knuckle pin**
2. **Axle case support**

Installation

1. Coat new shaft seal with grease and install in axle case as shown (Fig. 18).

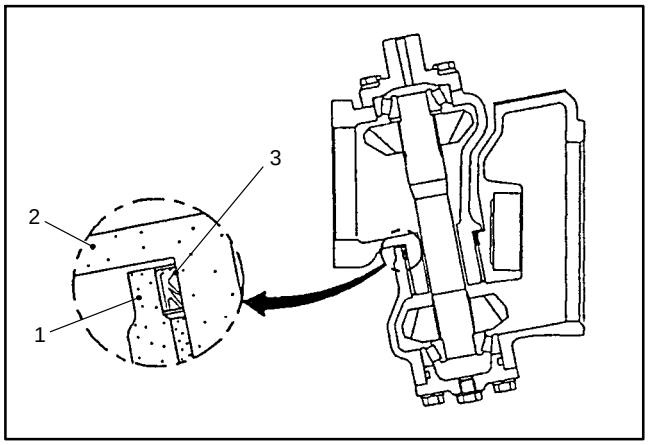

Figure 18

1. **Axle case**
2. **Bevel gear case**
3. **Shaft seal**

2. Install the lower bevel gear, and bevel gear shaft in the axle case cover. Coat a new O-ring with grease and install the axle case cover (Fig. 19). Tighten cover screws from 17 to 20 ft-lb (23 to 27 N−m).

3. Slide the bevel gear case over the bevel gear shaft and install the bevel gear and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Fig. 19).

4. Install the knuckle pin. Use medium strength Loctite thread locker and tighten the knuckle pin mounting screws from 17 to 20 ft-lb (23 to 27 N−m).

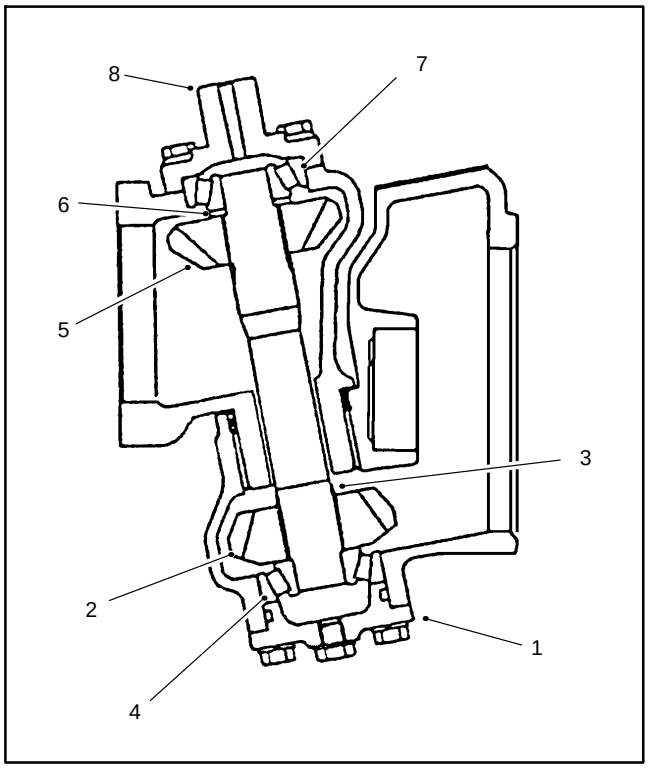

Figure 19

1. **Axle case cover**
2. **Lower bevel gear**
3. **Bevel gear shaft**
4. **Lower bearing**
5. **Upper bevel gear**
6. **Collar**
7. **Upper bearing**
8. **Knuckle pin**

5. Determine necessary quantity of support shims.

A. Lubricate the axle case support bushing with a thin coat of grease and slide axle case support onto knuckle pin.

B. Position support shims that were removed during disassembly between axle case support and axle case. Install mounting screws into axle case. Slowly tighten screws while frequently checking for clearance (vertical endplay) between axle case support and knuckle pin. If binding of components is noted before screws are fully tightened, add additional support shims. Torque screws from 57 to 67 ft−lb (77 to 91 N−m).

C. Use dial indicator to measure vertical endplay of axle case (Fig. 20).

AXLE CASE ASSEMBLY ENDPLAY:
0.001 to 0.008 in. (0.02 to 0.20 mm)

D. Adjust endplay by increasing or reducing number of axle case support shims.

NOTE: Axle case support shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.016 in. (0.4 mm) thickness.

6. After correct support shims have been determined, remove mounting screws, apply heavy strength thread−locking compound to screw threads, reinstall screws, and torque from 57 to 67 ft−lb (77 to 91 N−m).

IMPORTANT: Correct engagement between bevel gears is critical to axle performance and durability.

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 21).

UPPER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.020 in. (0.5 mm) thickness.

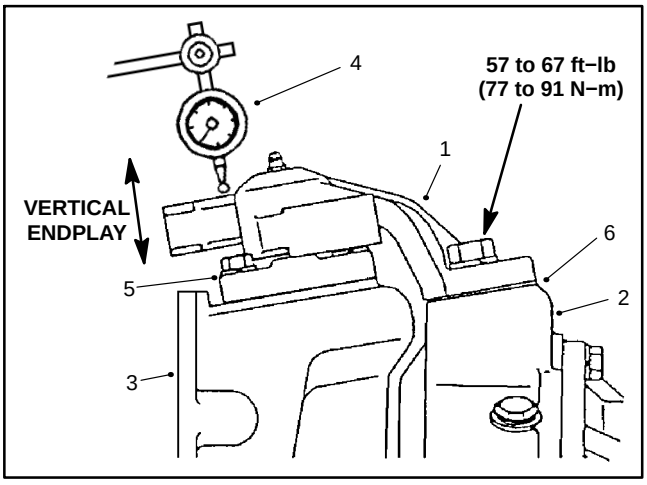

Figure 20

1. **Axle case support**
2. **Axle case**
3. **Bevel gearcase**
4. **Dial indicator**
5. **Knuckle pin**
6. **Support shim location**

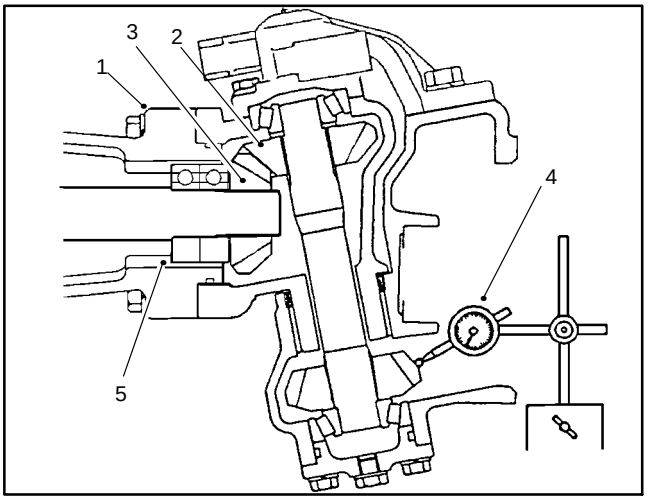

Figure 21

1. **Axle support**
2. **Upper bevel gear**
3. **Differential shaft gear**
4. **Dial indicator**
5. **Axle bearing shims**

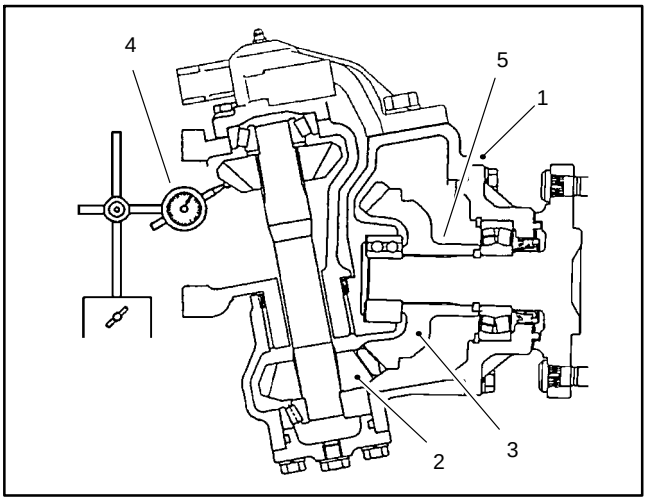

Figure 22

1. **Axle cover assembly**
2. **Lower bevel gear**
3. **Axle gear**
4. **Dial indicator**
5. **Axle bearing shims**

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 22).

LOWER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.008 in. (0.2 mm), 0.012 in. (0.3 mm), and 0.020 in. (0.5 mm) thickness.

11. Tighten axle cover screws from 17 to 20 ft-lb (23 to 27 N−m).

12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from 35 to 41 ft-lb (47 to 56 N−m) (Fig. 13).

Differential Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT: Do not interchange right and left differential shaft assemblies.

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 23).

2. Mark and pull the differential shaft assembly from the axle support.

3. Remove the retaining ring and bevel gear (Fig 24).

4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

5. Inspect all gears, shafts, bearings, and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.

2. Install bevel gear and retaining ring.

3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.

4. Install bevel gear case/axle case assembly (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

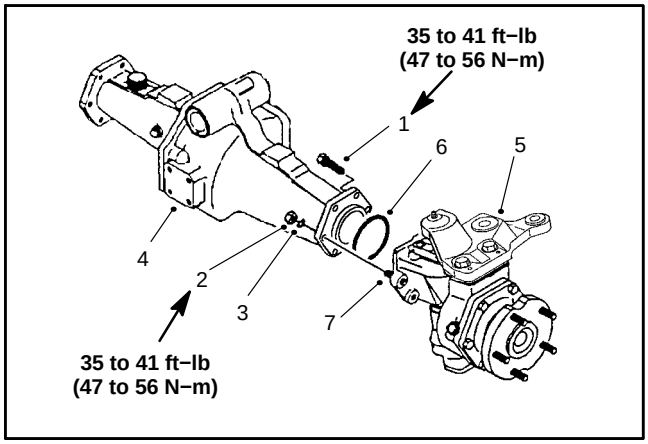

Figure 23

1. **Cap screw**
2. **Lock nut**
3. **Lock washer**
4. **Axle support**
5. **Bevel gear/axle case assembly**
6. **O-ring**
7. **Stud**

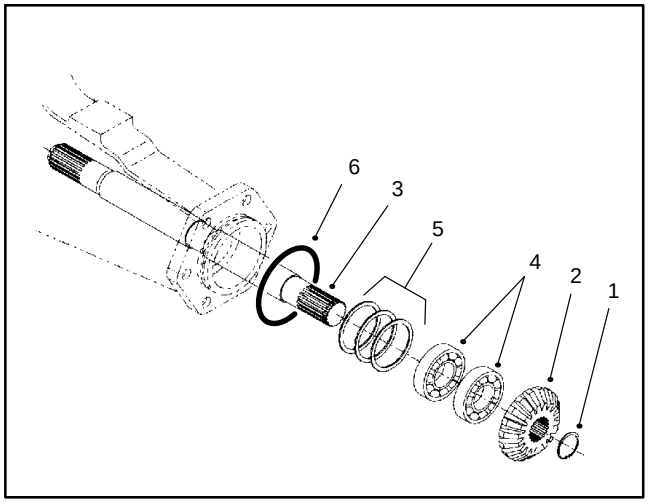

Figure 24

1. **Retaining ring**
2. **Bevel gear**
3. **Differential shaft**
4. **Bearing**
5. **Bearing shims**
6. **O-ring**

Axle Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 25).

2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 26).

3. Remove the shims, spacer, and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.

4. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

Installation

1. Coat new axle shaft seal with grease and install in axle cover as shown (Fig. 27).

2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 27).

3. Install retaining ring, spacer, and correct combination of bearing shims. Install bevel gear and bearing.

4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws from 17 to 20 ft-lb (23 to 27 N−m).

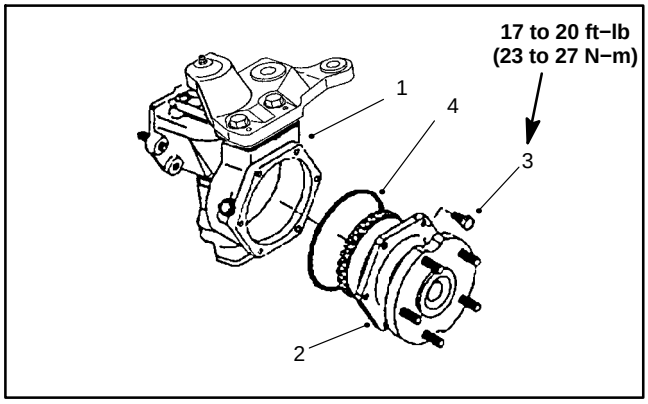

Figure 25

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw**
4. **O-ring**

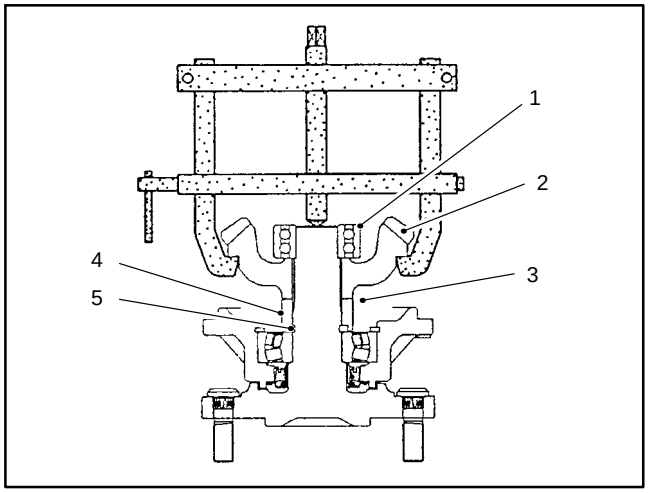

Figure 26

1. **Bearing**
2. **Bevel gear**
3. **Shims**
4. **Spacer**
5. **Retaining ring**

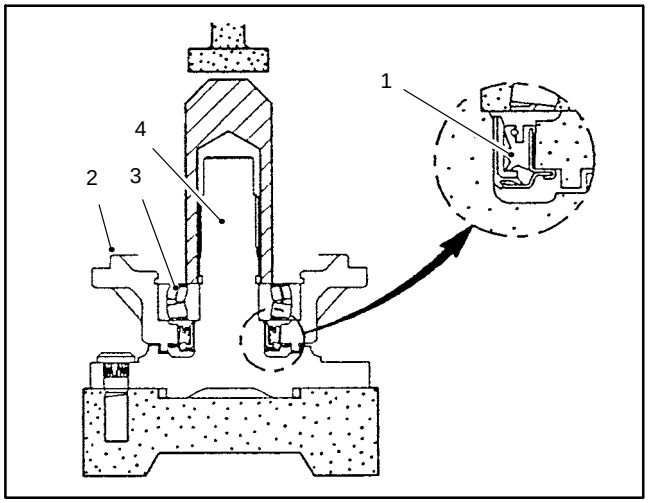

Figure 27

1. **Axle shaft seal**
2. **Axle cover**
3. **Bearing**
4. **Axle shaft**

Input Shaft/Pinion Gear

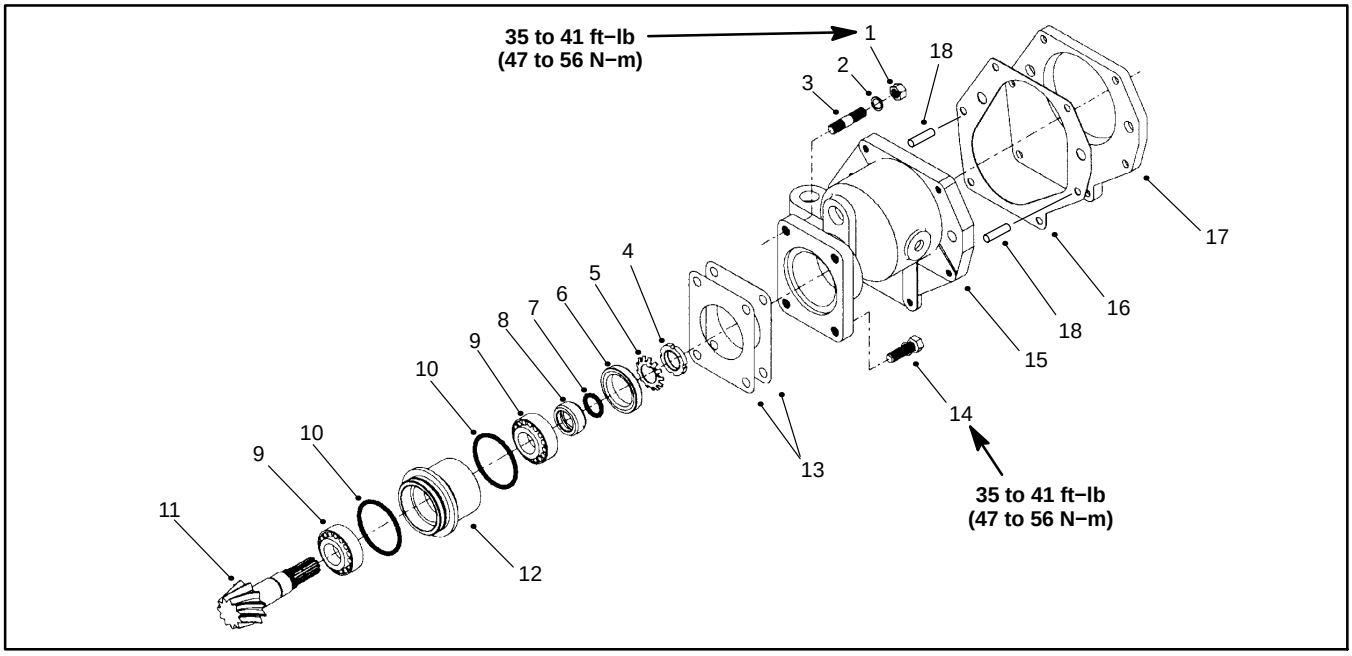

Figure 28

1. **Nut**
2. **Lockwasher**
3. **Stud**
4. **Locknut**
5. **Stake washer**
6. **Oil seal**
7. **O-ring**
8. **Seal collar**
9. **Bearing**
10. **O-ring**
11. **Input shaft/Pinion gear**
12. **Bearing case**
13. **Shim**
14. **Screw**
15. **Gear case**
16. **Gasket**
17. **Cover plate**
18. **Dowel pin**

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the cover plate, gasket, and gear case assembly from the axle assembly. Remove the gasket and any remaining gasket material.

2. Remove the retaining rings and the driven gear from the input shaft/pinion gear.

3. Remove input shaft/pinion gear assembly from the gear case. Remove the shims and bearing case O-rings.

4. Release the stake washer and remove the locknut. Remove and discard the stake washer.

5. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.

6. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

NOTE: Replacement input shaft/pinion gears are only available in matched ring and pinion sets.

Installation

NOTE: When installing new bearing cones, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.

2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

NOTE: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

3. Coat a new oil seal with grease and install as shown (Fig. 29). The seal should be installed with the garter spring towards the hydraulic motor.

4. Coat new O-ring with grease. Install O-ring in the oil seal collar, and install the collar.

5. Install a new stake washer. Install the lock nut finger tight.

6. Set the bearing preload by securing the bearing case in a vise. Thread a M12 x 1.5 hex head cap screw into the splined end of the input shaft/pinion gear and slowly tighten the locknut until 4 to 6 in-lb (0.4 to 0.7 N−m) of force is required to rotate the input shaft/pinion gear in the bearing case.

7. Secure the lock nut with the stake washer.

8. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the “Design Cone Center Distance” from this distance to determine initial shim thickness (Fig. 30).

DESIGN CONE CENTER DISTANCE
(distance from mating surface of axle support to end face of pinion gear):
1.870 ± 0.002 in. (47.5 ± 0.05 mm)

NOTE: Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) thickness.

9. Coat new O-rings with grease and install the bearing case in the gear case. Place shims on the gear case and temporarily install gear case assembly into axle case. Tighten mounting nuts and screws from 35 to 41 ft-lb (47 to 56 N−m).

10. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 31).

PINION GEAR TO RING GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

11. Adjust backlash by increasing or reducing gear case shim thickness.

12. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement in this section of this manual).

13. Place the correct combination of shims on the gear case. Tighten mounting nuts and screws from 35 to 41 ft-lb (47 to 56 N−m).

14. Install retaining rings and driven gear on input shaft/pinion gear.

15. If the drive gear (on drive motor shaft) was removed, install the retaining rings and drive gear on the motor shaft.

16. Use a new gasket and install the cover plate. Use a new O-ring and install the drive motor.

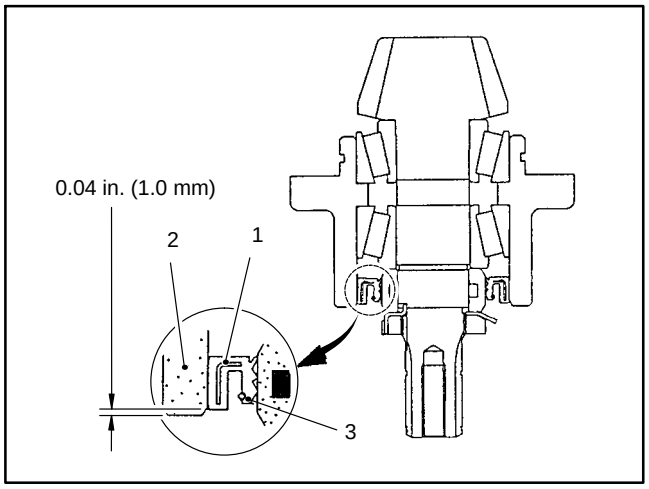

Figure 29

1. Oil seal
2. Bearing case
3. Seal garter spring

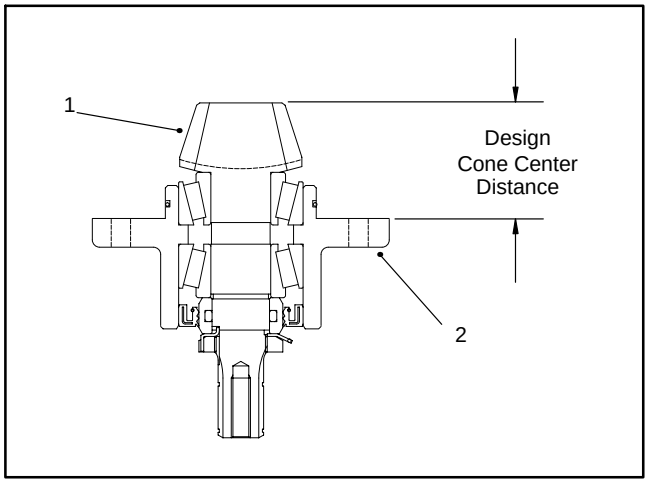

Figure 30

1. Input shaft/pinion gear
2. Bearing case

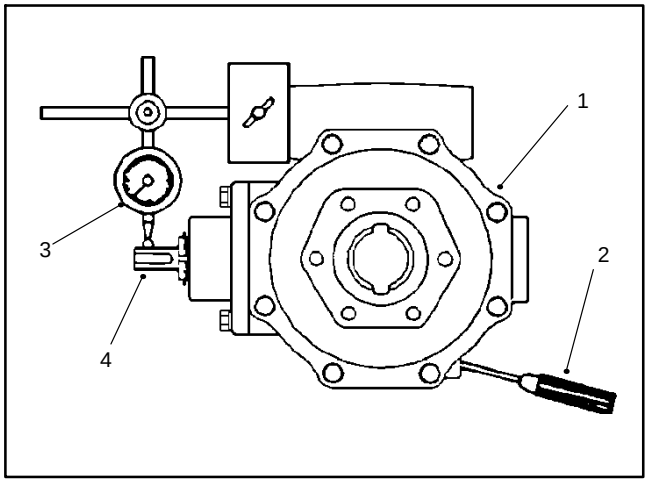

Figure 31

1. Axle case
2. Screwdriver
3. Dial indicator
4. Input shaft/pinion gear

Differential Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

IMPORTANT: Do not interchange right and left differential shafts assemblies.

2. Mark and pull the differential shaft assemblies from the axle support.

3. Remove input shaft/pinion gear assembly, shims, and O-ring from the axle support (Fig. 32).

4. Remove the axle support case screws. Separate the axle support halves and remove the O-ring.

5. Remove the differential gear assembly, bearings, and adjusting shims from the axle case.

6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Fig. 33).

NOTE: Mark and arrange all components so they can be reassembled in their original position.

7. Remove the differential pinion shaft, pinion gears, and pinion washers. Remove the differential side gears and side gear shims. Remove the ring gear only if it will be replaced (Fig. 34).

NOTE: Replacement ring gears are only available in matched ring and pinion sets.

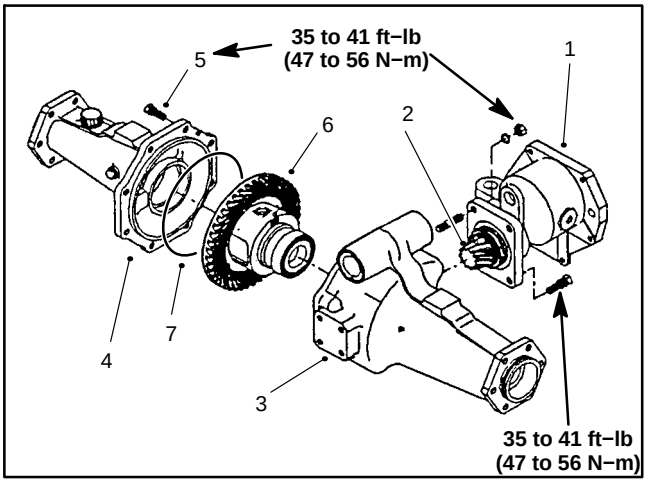

Figure 32

1. Gear Case
2. Pinion Gear
3. Axle support (left)
4. Axle support (right)
5. Case screw
6. Differential gear
7. O-ring

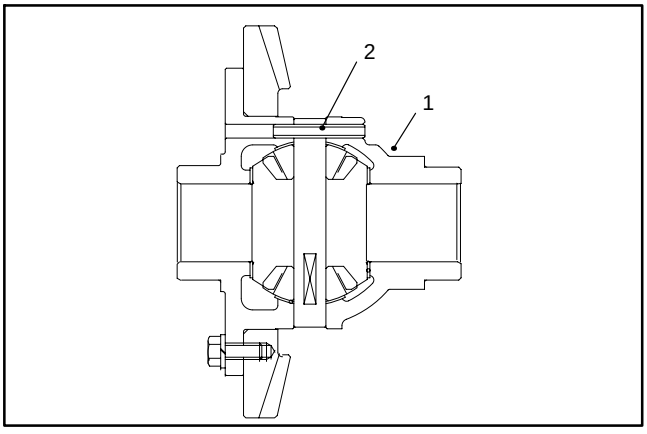

Figure 33

1. Differential case
2. Spring pin

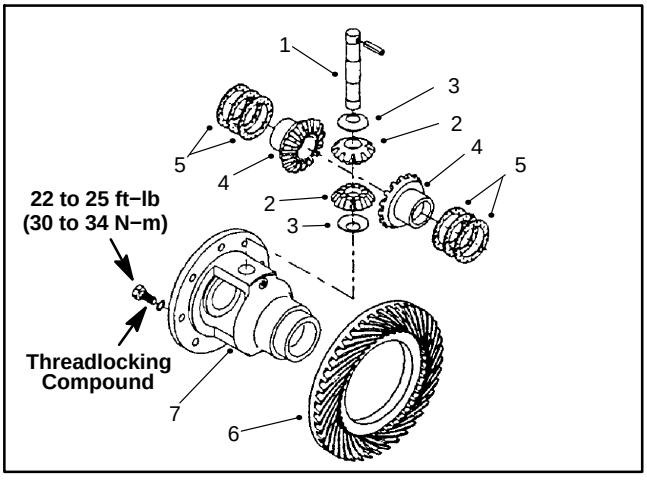

Figure 34

1. Differential pinion shaft
2. Pinion gear
3. Pinion washer
4. Side gear
5. Side gear shims
6. Ring gear
7. Differential case

Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 35). Replace components as necessary.

SIDE GEAR TO CASE CLEARANCE:
0.002 to 0.012 in. (0.05 to 0.30 mm)

SIDE GEAR O.D. (Factory Spec.):
1.335 to 1.337 in. (33.91 to 33.95 mm)

DIFFERENTIAL CASE I.D. (Factory Spec.):
1.339 to 1.341 in. (34.00 to 34.06 mm)

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Fig. 36). Replace components as necessary.

PINION SHAFT TO PINION GEAR CLEARANCE:
0.001 to 0.010 in. (0.03 to 0.25 mm)

PINION SHAFT O.D. (Factory Spec.):
0.550 to 0.551 in. (13.97 to 13.10 mm)

PINION GEAR I.D. (Factory Spec.):
0.551 to 0.552 in. (13.10 to 14.02 mm)

3. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

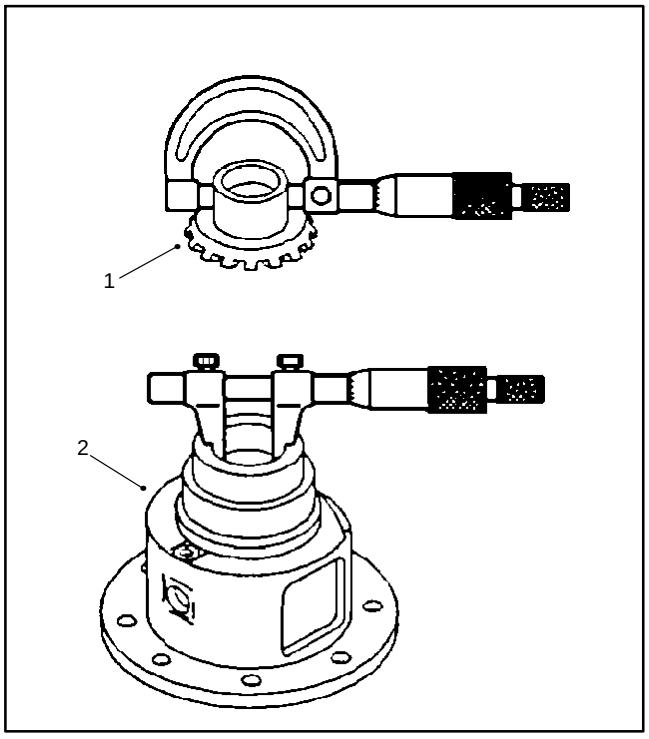

Figure 35

1. Side gear **2. Differential case**

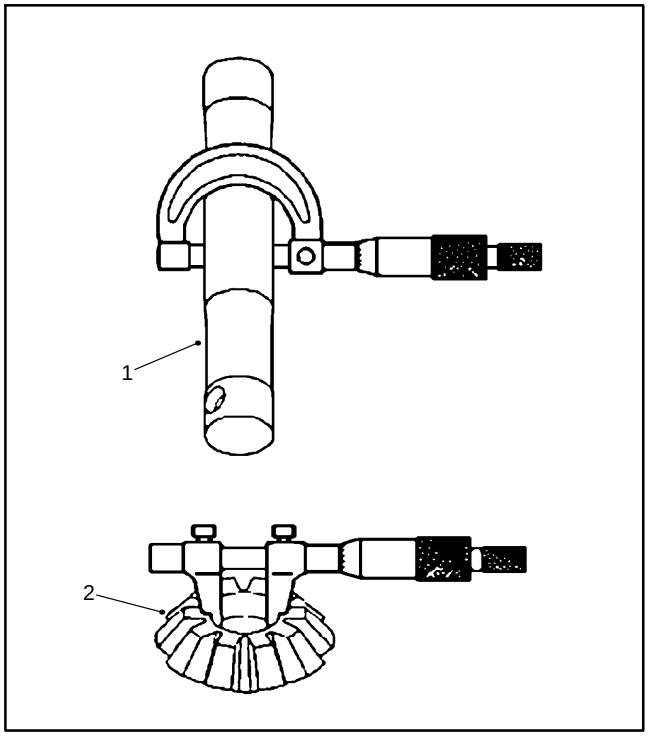

Figure 36

1. Pinion shaft **2. Pinion gear**

Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from 22 to 25 ft-lb (30 to 34 N−m).

2. Apply molybdenum disulfide lubricant (Three Bond 1901 or equivalent) to the splines and bearing surfaces of the differential pinion gears, pinion washers and side gears.

3. Install the side gear shims and side gears in their original location in the differential case.

4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.

5. Secure the differential case in a soft jawed vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Fig. 37).

PINION GEAR TO SIDE GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

6. Adjust backlash by increasing or reducing side gear shim thickness.

NOTE: Side gear shims are available in 0.043 in. (1.10 mm), 0.047 in. (1.20 mm) and 0.051 in. (1.30 mm) thickness.

7. Apply gear marking compound, such as DyKem® Steel Blue lightly over several gear teeth.

8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.

9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe (small) end (Fig. 38).

10. Adjust side gear shims if necessary to correct tooth contact. Recheck differential pinion gear to side gear backlash if any changes are made.

11. After backlash and tooth contact have been adjusted, align the hole in the differential pinion shaft with the hole in the differential case and install a new spring pin.

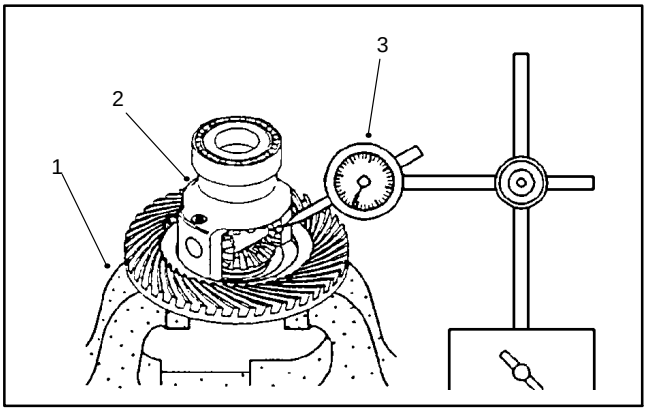

Figure 37

1. Vise
2. Differential gear case
3. Dial indicator

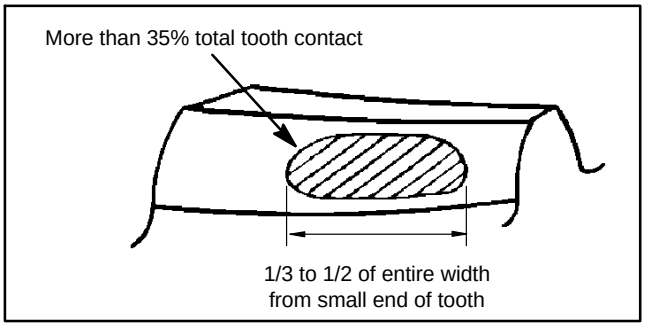

Figure 38

12. Install differential gear assembly in right side axle support half.

13. Coat a new o-ring with grease and install left side axle support half. Tighten axle support case screws from 35 to 41 ft-lb (47 to 56 N−m).

14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear in this section of this manual).

15. Coat new o-rings with grease, align differential shaft splines with differential gear assembly and slide differential shaft assemblies onto axle support.

16. Install bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

Pinion Gear to Ring Gear Engagement (4 Wheel Drive Axle)

The final position of the pinion gear is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 39):

Toe − the portion of the tooth surface at the end towards the center.

Heel − the portion of the gear tooth at the outer end.

Top Land − top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem® Steel Blue.

2. Install the input shaft/pinion gear assembly into axle case.

3. While applying a light load to the ring gear, rotate the pinion gear in the direction of forward travel until the ring gear has made one complete revolution.

Ideal tooth contact observed on the ring gear should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe end (Fig. 40).

Adjustments to the gear contact position are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Fig. 41).

NOTE: Bearing case shims are available in 0.004 in. (0.10 mm) and 0.008 in. (0.20 mm) thickness.

NOTE: Differential bearing shims are available in 0.004 in. (0.10 mm), 0.008 in. (0.20 mm) and 0.016 in. (0.40 mm) thickness.

Study the different contact patterns (Figs. 42 and 43) and correct gear engagement as necessary.

NOTE: When making changes, note that two variables are involved (see Gear Pattern Movement Summary in this section of this manual).

Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

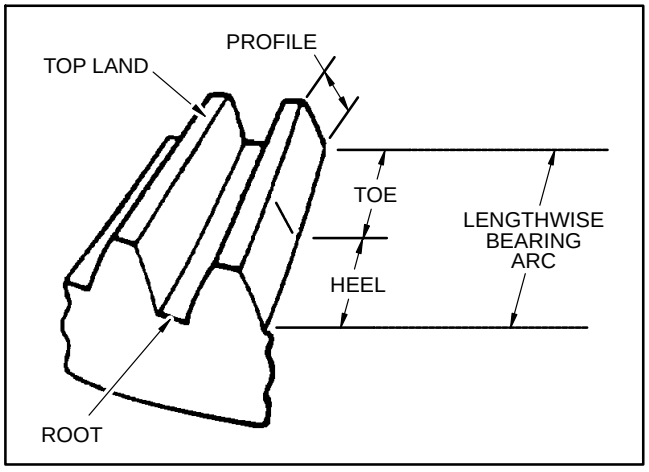

Figure 39

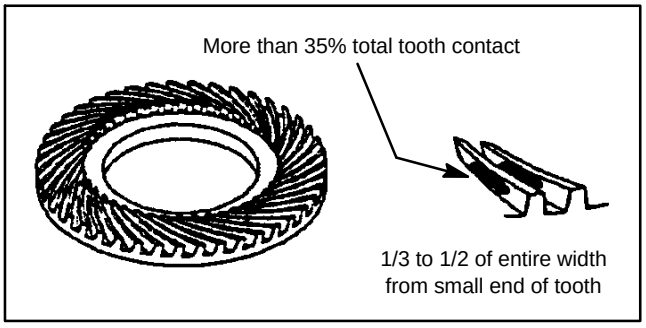

Figure 40

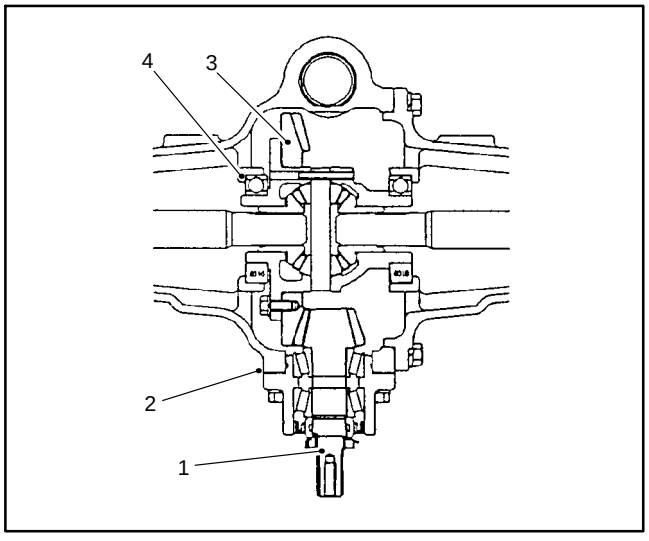

Figure 41

1. **Input shaft/pinion gear**
2. **Bearing case shims**
3. **Differential gear case**
4. **Differential bearing shims**

Gear Pattern Movement Summary

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Fig. 42):

   A. Install thicker or additional bearing case shim(s) to move pinion shaft toward ring gear.

   B. Install thinner or remove differential bearing shim(s) to move ring gear backward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

2. If contact is toward the toe or tip of the gear (Fig. 43):

   A. Install thinner or remove bearing case shim(s) to move pinion shaft away from ring gear.

   B. Install thicker or additional differential bearing shim(s) to move ring gear forward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

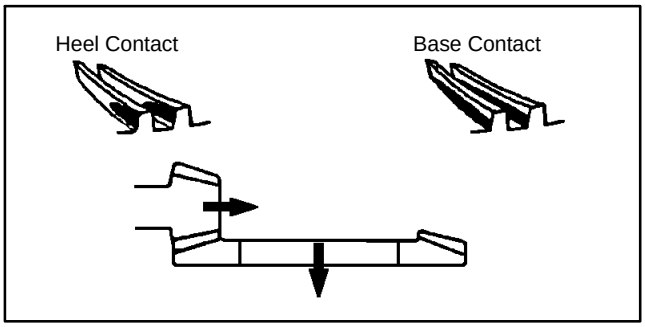

Figure 42

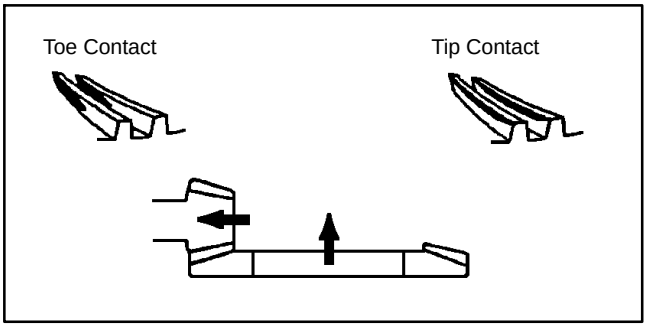

Figure 43

Chapter 7

Chassis

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- Front Deck Lift Arm 4
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- Side Deck Rear Arm Assembly 8
- Lift Arm Yoke Joint 12
- Hood 14

Steering Tower

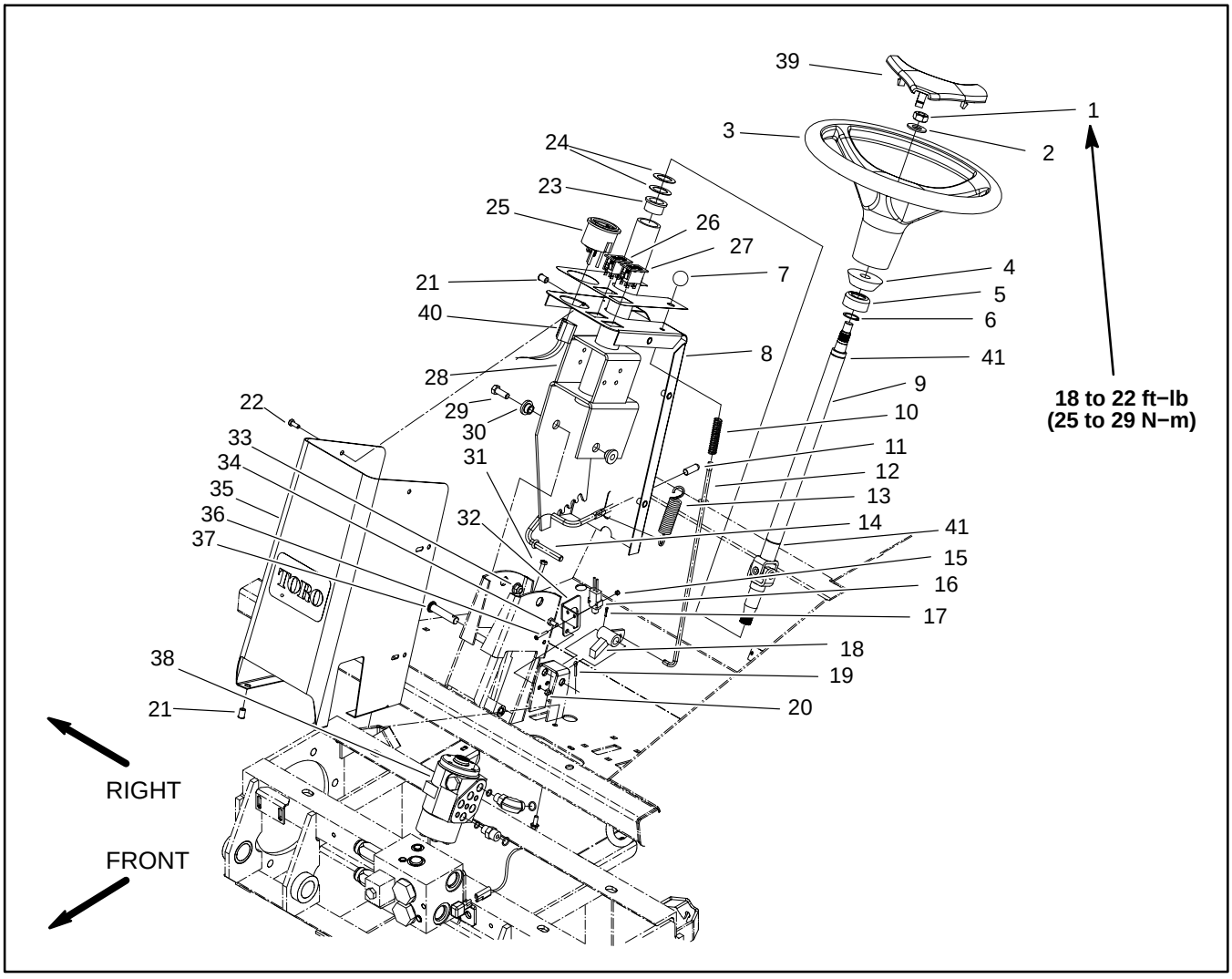

Figure 1

1. Hex nut
2. Flat washer
3. Steering wheel
4. Foam collar
5. Steering seal
6. External snap ring (2 used)
7. Knob
8. Steering tower cover
9. Steering shaft
10. Compression spring
11. Cap
12. Rod assembly
13. Extension spring
14. Tilt rod
15. Lock nut
16. Parking brake switch
17. Cotter pin
18. Brake pawl
19. Cotter pin
20. Lock nut
21. Nut insert
22. Flange head screw
23. Flange bushing
24. Thrust washer
25. Temperature gauge
26. Warning lamp (temp/glow plug)
27. Warning lamp (charge/oil pressure)
28. Steering column
29. Cap screw
30. Pivot hub
31. Flange head screw
32. Switch bracket
33. Flange nut
34. Cap screw
35. Steering tower
36. Phillips head screw
37. Clevis pin
38. Steering valve
39. Steering wheel cover
40. Front wire harness
41. Snap ring location

Disassembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Disassemble steering tower as needed using Figure 1 as a guide.

Assembly

1. Assemble steering tower using Figure 1 as a guide. **Note:** Thrust washer(s) (24) on steering column are used as needed to remove end play of steering shaft.

Front Deck Lift Arm

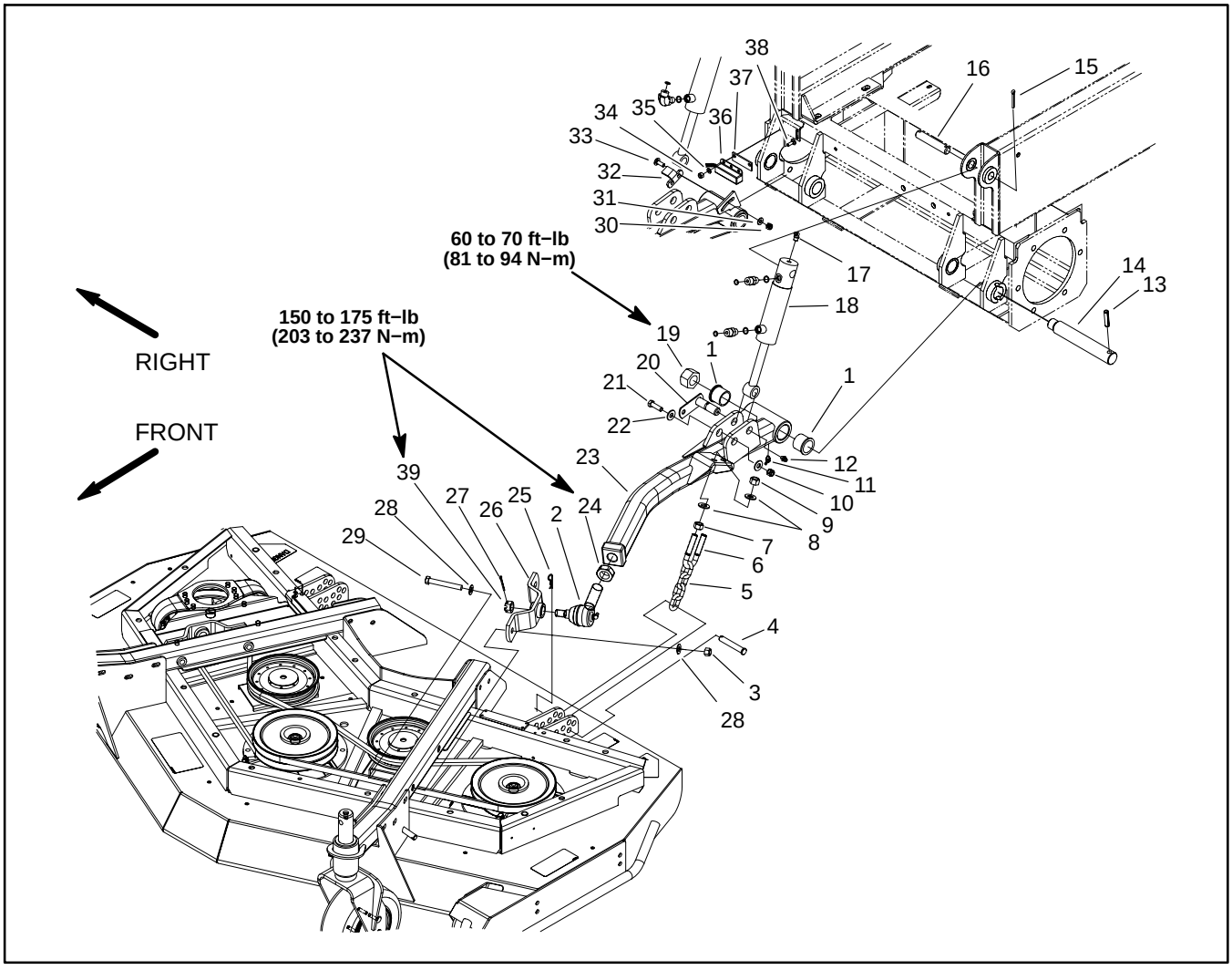

Figure 2

1. **Flange bushing**
2. **Ball joint**
3. **Lock nut**
4. **Clevis pin**
5. **Height−of−cut chain**
6. **U−bolt**
7. **Hex nut**
8. **Flat washer**
9. **Lock nut**
10. **Lock nut**
11. **Grease fitting (45º)**
12. **Grease fitting**
13. **Slotted roll pin**
14. **Lift arm pin**
15. **Cotter pin**
16. **Upper lift pin**
17. **Grease fitting**
18. **Lift cylinder**
19. **Lock nut**
20. **Pin**
21. **Cap screw**
22. **Flat washer**
23. **Lift arm (LH shown)**
24. **Jam nut**
25. **Hair pin**
26. **Ball joint mount**
27. **Cotter pin**
28. **Washer**
29. **Cap screw**
30. **Lock nut**
31. **Flat washer**
32. **Sensing plate**
33. **Carriage screw**
34. **Lock nut**
35. **Flat washer**
36. **Sensing switch**
37. **Spacer**
38. **Carriage screw**
39. **Slotted hex nut**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove front cutting deck (see Front Cutting Unit in Chapter 8 − Cutting Units).

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

3. Chock rear wheels and jack up front of machine. Support machine on jack stands.

4. Remove front wheel next to lift arm that is being removed.

5. Remove cap screw, washers, and lock nut that secure lift cylinder pin to lift arm. Remove pin and separate lift cylinder and lift arm.

6. Remove lock nut that secures lift arm pin. Support lift arm and slide pin from frame and lift arm. Remove lift arm from frame.

7. Remove height−of−cut chain, ball joint mount, and ball joint from removed lift arm as required.

Installation

1. Position lift arm to frame and insert lift arm pin. Engage roll pin into frame slots and install lock nut on pin. Torque lock nut from 60 to 70 ft−lb (81 to 94 N−m).

2. Align lift cylinder with lift arm. Slide pin through lift arm and cylinder end. Secure pin with cap screw, washers, and lock nut.

3. Install front wheel assembly.

4. Lower machine to the ground.

5. If height−of−cut chain u−bolt was removed from lift arm, assemble u−bolt so that threaded portion extends .870” (22.1 mm) above mounting plate on lift arm (Fig. 3).

6. If removed, install ball joint to lift arm. Distance from end of lift arm to center of ball joint should be from 2.210” to 2.390” (56.1 to 60.7 mm) (Fig. 4). Make sure that ball joint is horizontal and that stud is centered in ball joint. Torque ball joint jam nut from 150 to 175 ft−lb (203 to 237 N−m).

7. Install ball joint mount to ball joint with slotted hex nut. Torque nut from 150 to 175 ft−lb (203 to 237 N−m) while aligning cotter pin holes. Install cotter pin.

8. Install front cutting deck (see Front Cutting Unit in Chapter 8 − Cutting Units).

9. Lubricate lift arm grease fittings (see Operator’s Manual).

10. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

11. Check height−of−cut and deck pitch adjustment (see Operator’s Manual).

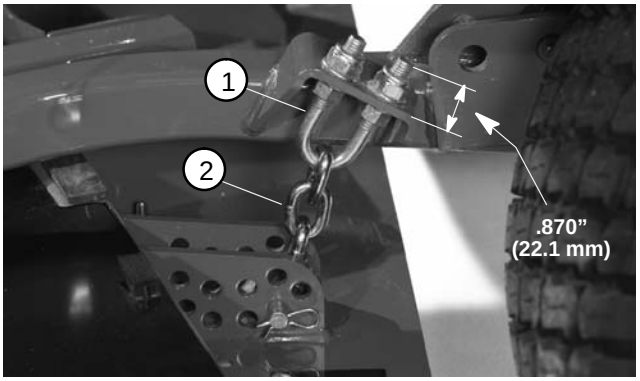

Figure 3

1. U−bolt **2. Height−of−cut chain**

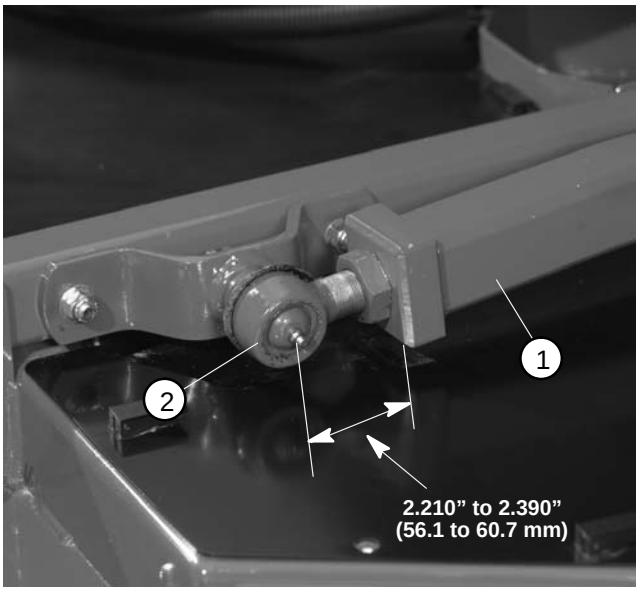

Figure 4

1. Lift arm **2. Ball joint**

Side Deck Lift Arm

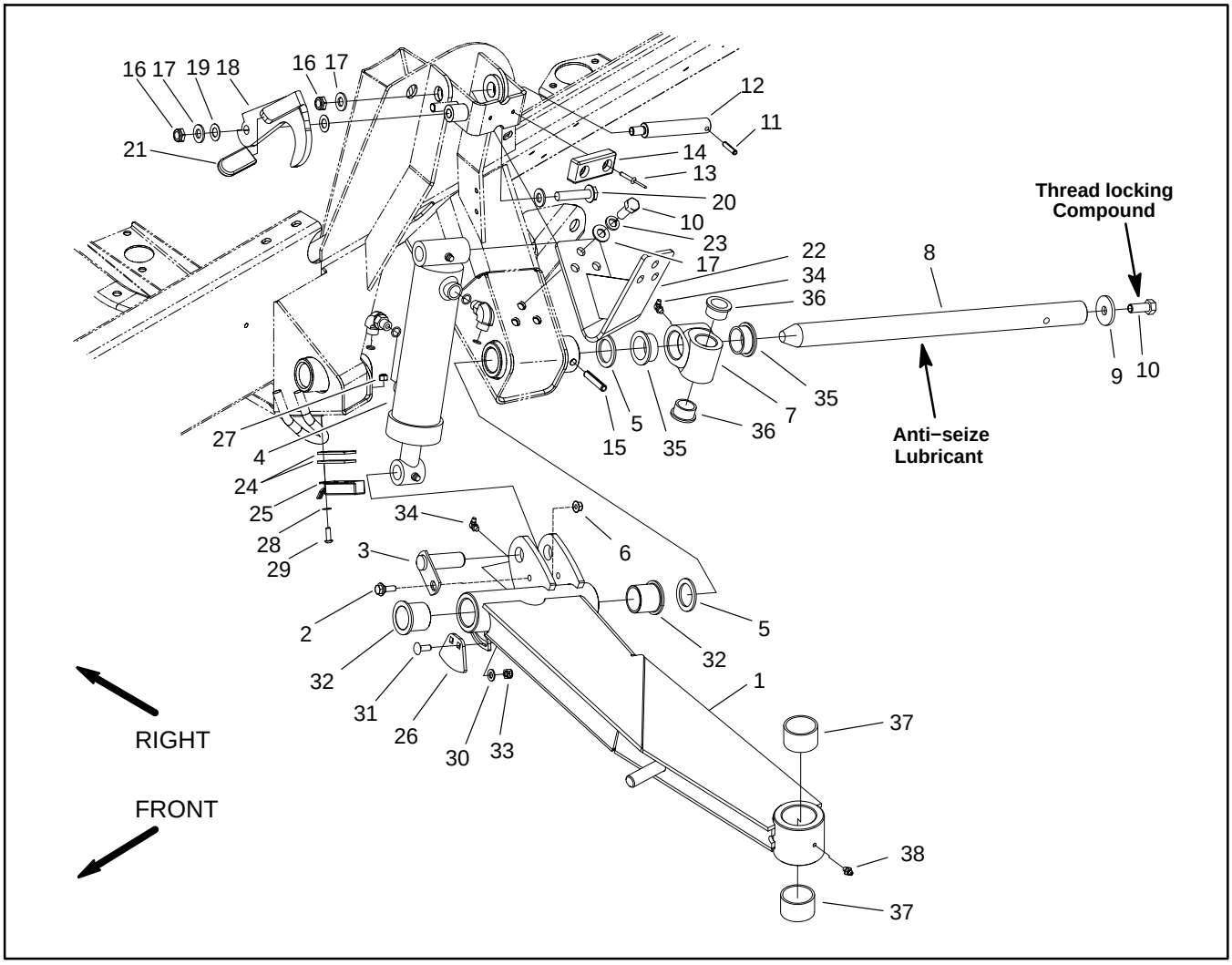

Figure 5

1. Lift arm (LH shown)
2. Shoulder screw
3. Lift cylinder pin
4. Lift cylinder
5. Thrust washer
6. Flange nut
7. Pivot hub
8. Lift arm pivot shaft
9. Thrust washer
10. Cap screw
11. Spring pin
12. Cylinder pin
13. Rivet
14. Rubber bumper
15. Slotted roll pin
16. Lock nut
17. Flat washer
18. Latch (LH shown)
19. Thrust washer
20. Flange head screw
21. Plastic grip
22. Cam bracket
23. Lock washer
24. Switch spacer
25. Sensing switch
26. Sensing plate
27. Lock nut
28. Flat washer
29. Socket head screw
30. Flat washer
31. Carriage screw
32. Flange bushing
33. Lock nut
34. Grease fitting
35. Flange bushing
36. Flange bushing
37. Bushing
38. Grease fitting

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove side deck from lift arm (see Side Cutting Unit in Chapter 8 − Cutting Units).

3. Remove side deck rear arm assembly from pivot hub (see Side Deck Rear Arm Assembly).

4. Remove lift cylinder pin that secures lift cylinder to lift arm.

5. Drive out roll pin that retains lift arm pivot shaft. Discard roll pin.

6. Support lift arm and pull lift arm pivot shaft from lift arm and frame. Locate and remove thrust washers during pivot shaft removal.

   A. If pivot shaft is difficult to remove, fabricate a puller as shown in Figure 6. Attach puller to end of pivot shaft with the pictured bolt and flat washer. Drive pivot shaft from lift arm and frame with hammer.

7. Remove lift arm from machine.

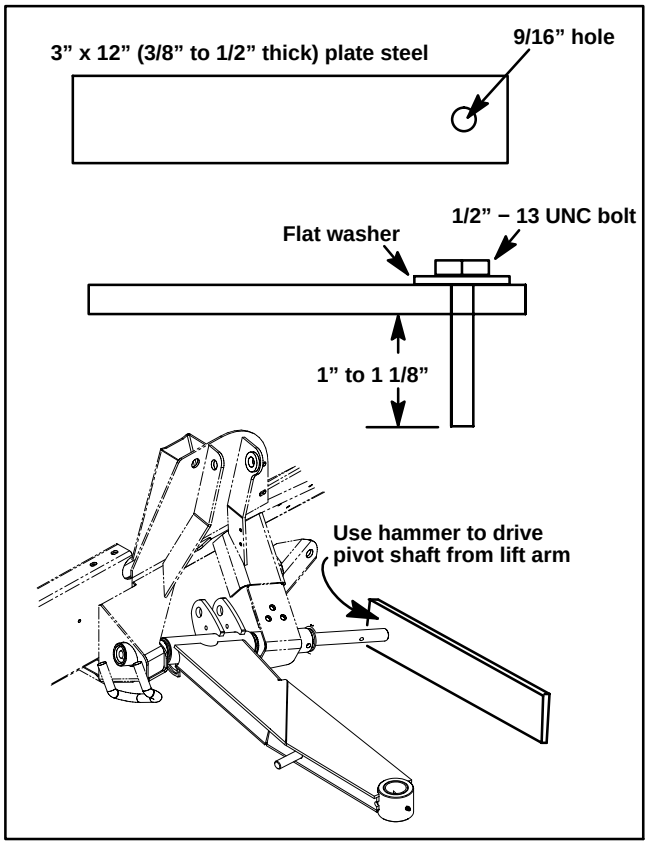

Figure 6

Installation

1. Apply anti−seize lubricant to lift arm pivot shaft.

2. Position lift arm to frame with thrust washers properly placed (Fig. 5). Slide pivot shaft into frame and lift arm until roll pin holes align.

3. Install new roll pin to secure lift arm pivot shaft.

4. If pivot hub was removed from pivot shaft, slide pivot hub on shaft. Apply thread locking compound to cap screw and secure pivot hub with washer and cap screw.

5. Install side deck rear arm assembly (see Side Deck Rear Arm Assembly).

6. Position and install side cutting deck to machine (see Side Cutting Unit in Chapter 8 − Cutting Units).

7. Lubricate lift arm grease fittings after assembly is complete (see Operator’s Manual).

8. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Side Deck Rear Arm Assembly

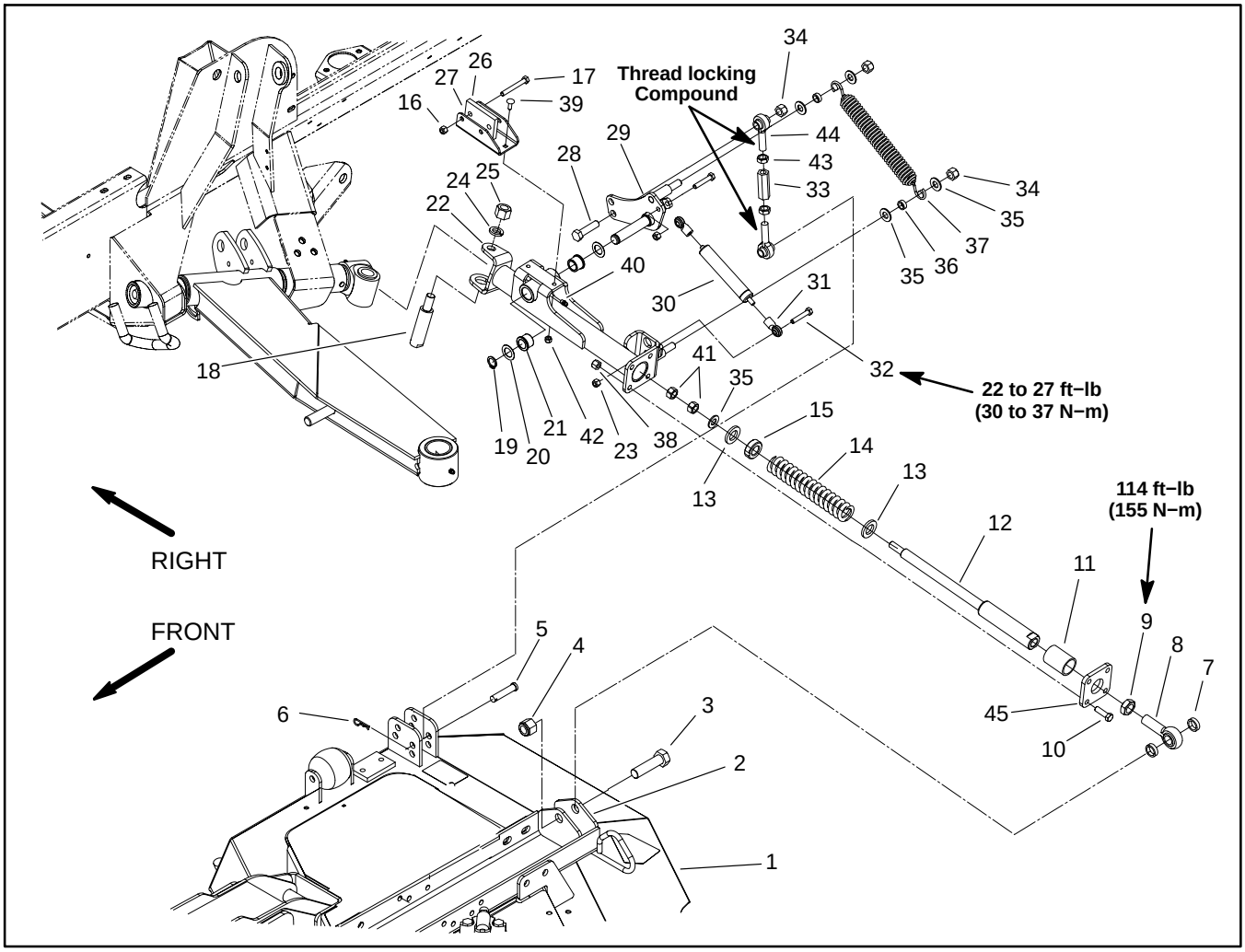

Figure 7

1. Cutting deck (LH shown)
2. Deck mount (LH shown)
3. Cap screw
4. Lock nut
5. Clevis pin
6. Hair pin
7. Spacer
8. Rod end
9. Jam nut
10. Cap screw
11. Straight bushing
12. Spring shaft
13. Flat washer
14. Compression spring
15. Plastic bearing
16. Lock nut
17. Cap screw
18. Pivot shaft
19. Retaining ring
20. Thrust washer
21. Flange bushing
22. Rear arm (LH shown)
23. Lock nut
24. Lock washer
25. Lock nut
26. Bumper pad
27. Bumper bracket
28. Cap screw
29. Bell crank (LH shown)
30. Damper
31. Damper rod end
32. Cap screw
33. Link tube
34. Lock nut
35. Flat washer
36. Bushing
37. Damper spring
38. Lock nut
39. Carriage screw
40. Grease fitting
41. Jam nut
42. Lock nut
43. Jam nut
44. Rod end
45. Plate

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove hair pin and clevis pin that connects damper link to cutting deck (Fig. 8).

3. Remove cap screw and lock nut that secures rod end of rear arm to cutting deck. Locate and remove spacer from each side of rod end.

4. Remove lock nut and lock washer that secures rear arm pivot shaft. Slide pivot shaft from hub and rear arm. Remove rear arm assembly from machine.

Disassembly

1. Disassemble rear arm assembly using Figure 7 as a guide. **Note:** early models use rear arm components as shown in Figure 9. On these models, roll pin removal will allow coupler to be separated from spring shaft.

Assembly (Figure 7)

1. Slide large flat washer, spring, plastic bearing, another large flat washer and small flat washer onto spring shaft. Loosely secure components to shaft with one jam nut.

2. Slide the straight bushing and plate onto other end of spring shaft.

3. While holding flats on end of spring shaft, rotate jam nut (on other end of assembly) until components are snug but spring is not compressed.

4. Insert assembly into rear arm housing.

5. From open end of rear arm housing, insert a 3/4" socket onto spring shaft jam nut. Tighten jam nut fully.

6. Mount plate to rear arm housing with two cap screws and lock nuts. Grasp end of spring shaft. Push inward and pull outward on shaft to determine endplay in assembly.

IMPORTANT: All endplay must be removed from assembly to allow proper operation and ensure long life.

7. Loosen jam nut, 1/2 turn at a time, until all endplay in shaft is removed.

8. Remove two cap screws and nuts securing plate to rear arm housing. Remove spring shaft assembly from housing.

9. Thread remaining jam nut onto end of spring shaft and tighten to lock adjustment.

10. Thoroughly pack spring with grease. Install spring shaft assembly into housing and secure plate with four cap screws and lock nuts.

11. Thread rod end with jam nut into end of spring shaft. Do not tighten jam nut at this time.

12. If rod ends (31) were removed from damper (30), apply thread locking compound to damper shaft threads before installing rod ends. Secure damper to bellcrank and rear arm with cap screws and lock nuts. Torque fasteners from 22 to 27 ft−lb (30 to 37 N−m).

13. If damper link was disassembled, adjust the length of the link to 5.370" ± .075" (13.6 cm ± .2 cm) (Fig. 8).

14. If damper springs (37) were removed, tighten lock nuts so that bushings (36) are free to rotate.

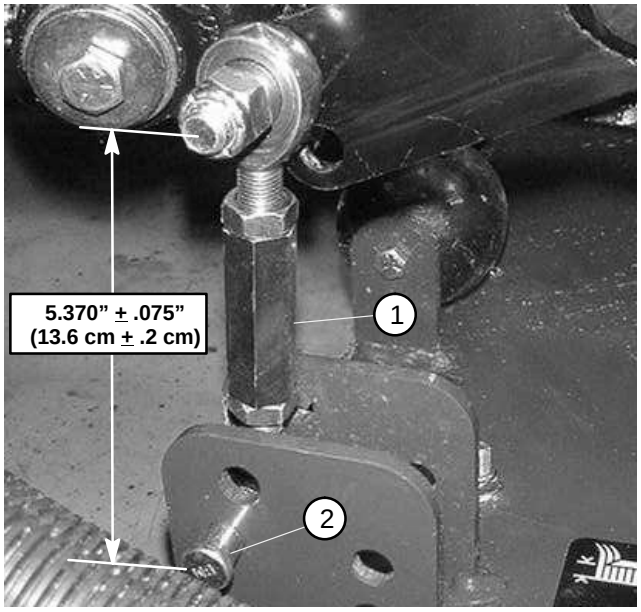

Figure 8

1. **Damper link**
2. **Clevis pin**

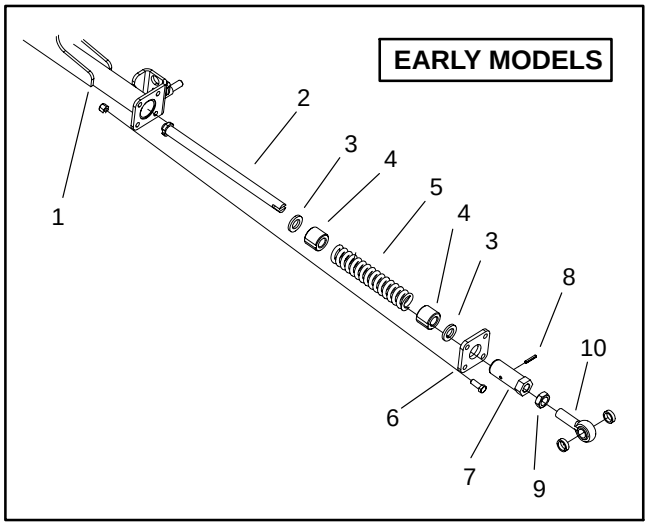

Figure 9

1. **Rear arm**
2. **Spring shaft**
3. **Flat washer**
4. **Bushing**
5. **Compression spring**
6. **Plate**
7. **Coupler**
8. **Roll pin**
9. **Jam nut**
10. **Rod end**

Installation

1. Position rear arm assembly to cutting deck and frame.

2. Slide pivot shaft through rear arm clevis and hub. Secure pivot shaft with lock washer and locknut.

3. Connect damper link to cutting deck with clevis pin and hair pin (Fig. 8).

4. Position spacers on both sides of rod end of rear arm assembly. Secure rod end of rear arm to deck mount with cap screw and lock nut.

5. Lubricate rear arm grease fittings (see Operator's Manual).

6. Align cutting deck to traction unit as follows:

   A. Make sure the machine is on a level, hard surface.

   B. Place a square or straight edge against the deck weldment that contains the castor fork assembly (Fig. 10). Do not use the castor fork assembly itself.

   C. Measure from the inset bead of the rim (not the outer edge of the rim) to the straight edge at two locations as indicated in Figure 10. Rim and paint irregularities make the rim outer edge an unreliable point of measure. These two measurements should be the same within a tolerance of 1/8" (3 mm).

   D. Rotate spring shaft in rear arm assembly until correct dimension is attained. Shaft will rotate freely inside the assembly. All adjustments must be made with the rod end of the rear arm bolted to the deck.

   E. Raise and lower the deck and recheck dimensions for correct alignment. Tighten rod end jam nut to 114 ft−lb (155 N−m) on the rear arm assembly.

NOTE: Due to differences in grass conditions and the counterbalance setting of traction unit, it is advised that grass be cut and appearance checked before formal cutting is started. Refer to Operator's Manual for correcting cutting unit mismatch procedures.

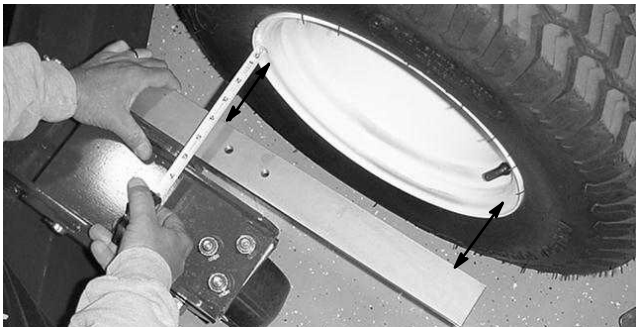

Figure 10

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Lift Arm Yoke Joint

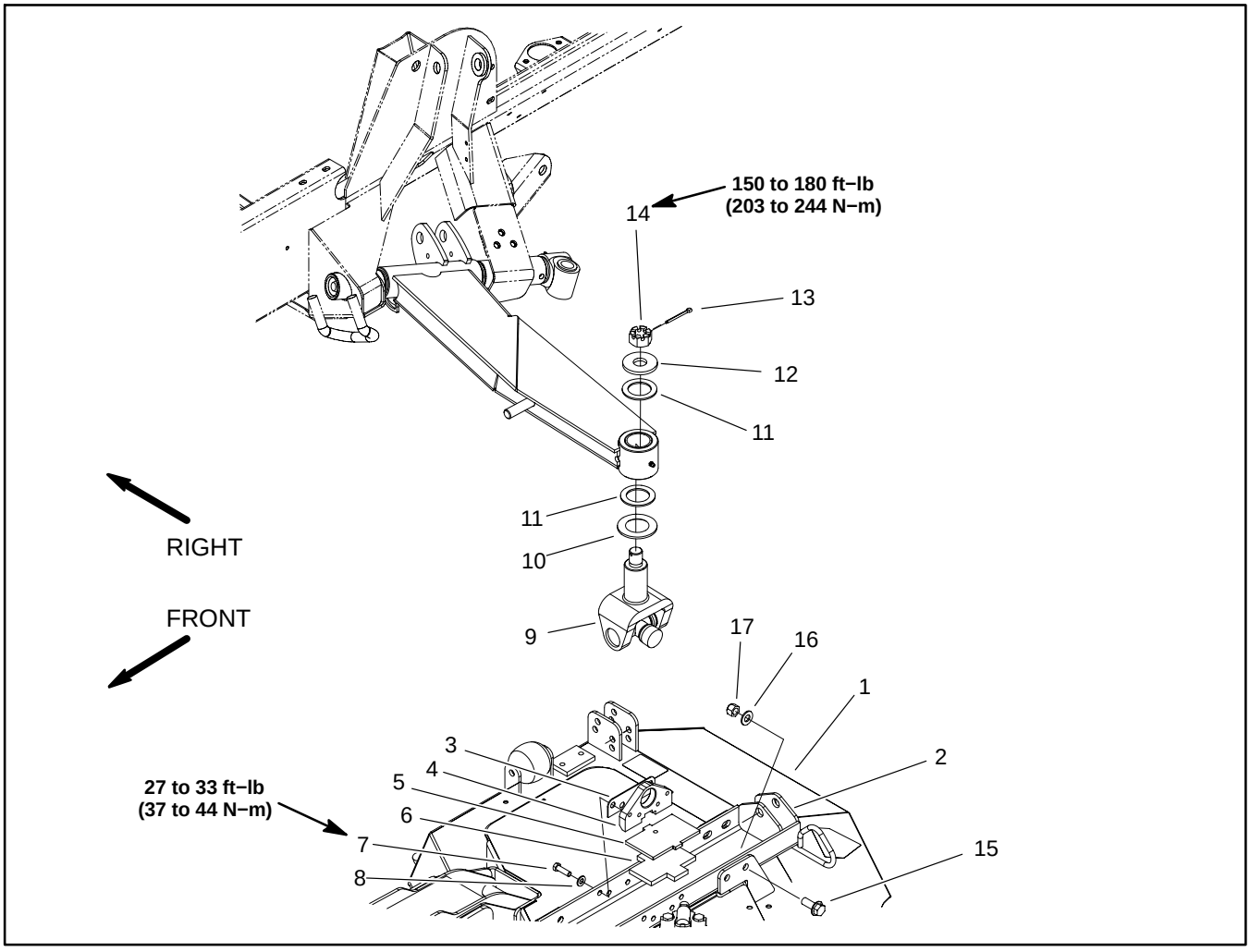

Figure 11

1. Side cutting deck (LH shown)
2. Deck mount (LH shown)
3. Shim
4. Base mount
5. Plate
6. Rubber pad
7. Cap screw
8. Flat washer
9. Yoke joint
10. Spacer
11. Thrust washer
12. Hardened washer
13. Cotter pin
14. Slotted hex nut
15. Flange head screw
16. Flat washer
17. Lock nut

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove eight flange head screws, flat washers, and lock nuts that secure deck mount to cutting deck.

3. Remove cotter pin from yoke joint shaft. Make sure that deck mount is supported and remove slotted hex nut that secures yoke joint to lift arm. Take hardened washer and thrust washer from yoke joint shaft. Raise lift arm enough to free yoke joint from lift arm. Remove second thrust washer and spacer washer from yoke shaft.

4. Remove cap screws and flat washers that secure base mounts to deck mount.

5. Lift yoke joint and base mounts from deck mount. Remove shims, plate, and rubber pad from deck mount.

6. Press yoke joint from base mounts.

Yoke Joint Disassembly

1. Remove snap rings from yoke (Fig. 12).

IMPORTANT: Support yoke when removing and installing cross and bearings to prevent yoke damage.

2. Use a press to remove cross and bearing assembly from yoke.

Yoke Joint Assembly

1. Apply a coating of grease to bearing bores of yoke.

2. Press one bearing partially into yoke.

3. Insert cross into yoke and bearing.

4. Hold cross in alignment and press bearing in until it hits the yoke.

5. Install snap ring to secure installed bearing.

6. Place second bearing into yoke bore and onto cross shaft. Press second bearing into yoke and install snap ring.

Installation

1. Press yoke joint to cutting deck base mounts with the angled edge of the mount assembled away from the joint (Fig. 12). The outside of the yoke bearing cup should be flush with the mount surface.

2. Place rubber pad and plate into deck mount. Make sure that tabs on plate and pad align with slots in base mount.

3. Position yoke joint with base mounts to deck mounts (Fig. 12) and install shims. Secure base mounts with cap screws and flat washers. Torque screws from 27 to 33 ft−lb (37 to 44 N−m).

4. Place spacer washer (chamfered ID side down) and then thrust washer onto yoke joint shaft. Insert yoke shaft up through lift arm bushings. Place additional thrust washer and then hardened washer on yoke shaft and secure with slotted hex nut. Torque nut from 150 to 180 ft−lb (203 to 244 N−m) while aligning hole in shaft with slot in nut. Install cotter pin.

5. Secure deck mount to cutting deck with eight flange head screws, flat washers, and lock nuts.

6. Grease yoke joint and lift arm bushing after installation on machine (see Operator's Manual).

7. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

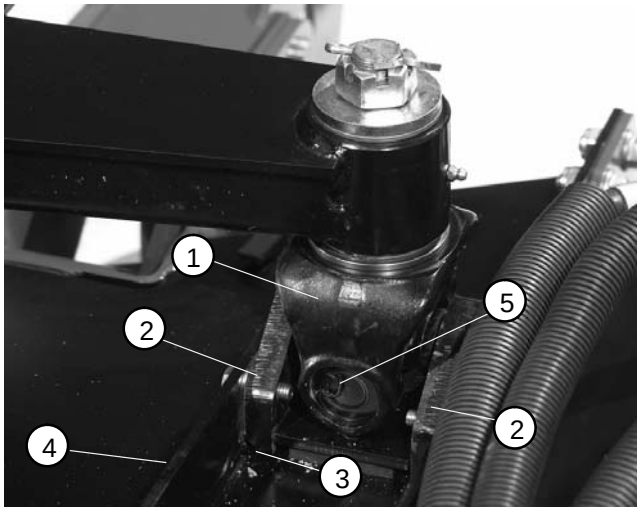

Figure 12

1. **Joint yoke**
2. **Base mount**
3. **Angled edge of mount**
4. **Deck mount**
5. **Snap ring**

Hood

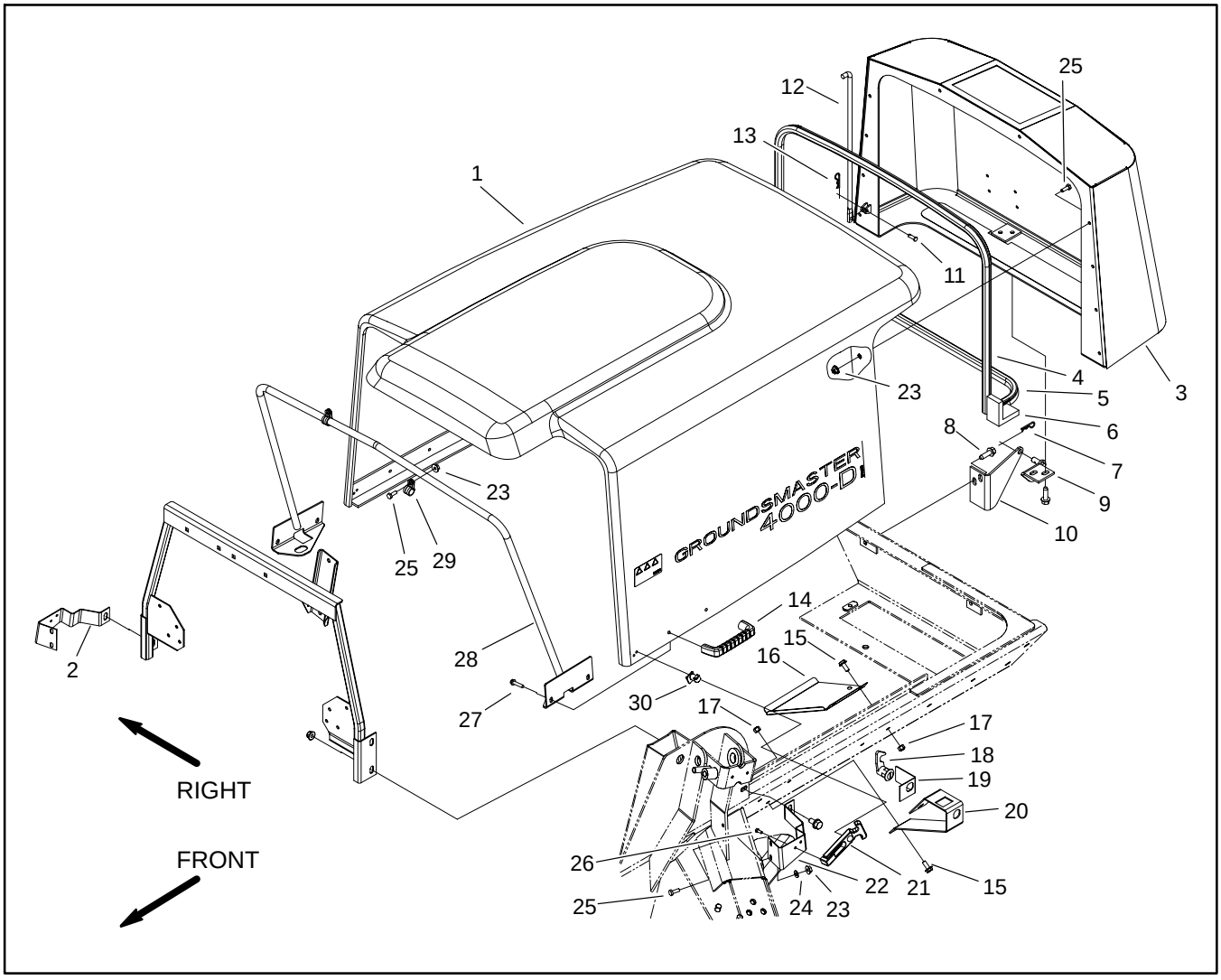

Figure 13

1. Hood
2. Latch bracket (RH)
3. Screen assembly
4. Bulb seal
5. Bulb seal
6. Screen seal corner
7. Hair pin
8. Flange head screw
9. Screen pivot
10. Hood pivot
11. Clevis pin
12. Hood rod
13. Hair pin
14. Door handle
15. Flange head screw
16. Oil filter deflector
17. Lock nut
18. Latch
19. Latch plate
20. Hood latch bracket
21. Flexible latch draw
22. Latch bracket (LH)
23. Flange head nut
24. Flat washer
25. Cap screw
26. Cap screw
27. Hex flange screw
28. Hood support
29. R−clamp
30. Latch keeper

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove hood using Figure 13 as a guide.

Installation

1. Install hood using Figure 13 as a guide.

2. Align hood to machine to allow correct operation of hood latch and dust seals:

   A. Place shim (3/8” to 7/16” thick) on top of frame (both RH and LH sides) near the sides of oil cooler (Fig. 14).

   B. Close hood so that it rests on shims and fasten the hood latches.

   C. Loosen hood pivots at frame to adjust vertical placement of pivots. Re−tighten hood pivot fasteners.

   D. Loosen screen pivots to allow hood latches to pull hood against radiator support. Re−tighten screen pivot fasteners.

3. After hood is assembled to machine, check for the following:

   A. Check that bulb seals are equally compressed at all contact points with hood.

   B. Hood should open and close without contacting oil cooler hardware.

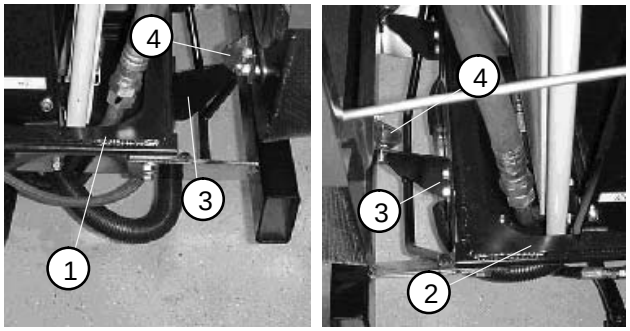

Figure 14

1. **Shim location (LH)**
2. **Shim location (RH)**
3. **Hood pivot**
4. **Screen pivot**

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Chapter 8

Cutting Units

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Specifications

MOUNTING: Cutting decks are supported by lift arms controlled with individual hydraulic lift levers.

CONSTRUCTION: Deck chamber is welded 12 gauge steel construction reinforced with channels and plates.

HEIGHT−OF−CUT RANGE: 1” to 5” (2.54 cm to 12.7 cm) in 1/2” (1.27 cm) increments. Front deck height−of−cut adjustment is achieved by changing spacers on castor wheels and adjusting length of deck support chains. Side deck adjustment requires adding or removing spacers from the castor forks, re−positioning the castor wheel axles in the castor forks, and securing the pivot arms to the correct height−of−cut bracket holes.

DECK DRIVE: Closed loop hydraulic system operates hydraulic motor on each cutting deck. Motor drives one spindle directly with remaining deck spindle(s) driven by B section kevlar v−belt(s). Blade spindles are 1−1/4” (3.17 cm) shafts supported by greaseable, tapered roller bearings.

CUTTING BLADE: Cutting blade dimensions are 21.75” (55.2 cm) long, 2.5” (6.4 cm) wide, and .25” (.64 cm) thick. Anti−scalp cup installed on each cutting blade. Three blades on front deck and two blades on each side deck.

WIDTH OF CUT: Front deck provides 62” (157.5 cm) width of cut. Each side deck has 42” (106.7 cm) width of cut. Total width of cut is 132” (335.3 cm) with 7” (12.8 cm) overlap.

DISCHARGE: Clippings are discharged from the rear of the cutting decks. Provided mounting holes allow attachment of optional Guardian Recycler Kit.

SUSPENSION SYSTEM: A fully floating suspension with hydraulic counterbalance. Front deck suspended at rear from lift arms and has two castor wheels, two adjustable skids, and two anti−scalp rollers. Each side deck supported by three castor wheels and a spring damper system which connects the fourth deck corner to the traction unit. There is a main lift arm that provides counterbalance to the side decks along with a rear anti−rotation link which also provides bi−directional impact protection. Optional Guardian Recycler Kit includes one anti−scalp roller on each cutting deck.

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, uneven ground conditions, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine.

Remember that the “effective” or actual height−of−cut depends on cutting unit weight, tire pressures, hydraulic counterbalance settings, and turf conditions. Effective height−of−cut will be different than the bench set height−of−cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust speed to specifications if necessary.
2. Blade speed.	All deck blades should rotate at the same speed. See items in Troubleshooting Section of Chapter 4 − Hydraulic System.
3. Tire pressure.	Check air pressure of each tire including castor tires. Adjust to pressures specified in Operator’s Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that cutting chambers are in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height−of−cut.	Make sure all cutting units are set at the same height−of−cut. Set units as specified in the Operator’s Manual.
7. Cutting unit alignment and ground following.	Check lift arms and cutting unit pivot linkages for wear, damage, or binding. Also, inspect for bent or damaged pivot shafts.
8. Roller and castor wheel condition.	All rollers and caster wheels should rotate freely. Replace bearings if worn or damaged.
9. Grass conditions.	Mow when grass is dry for best cutting results. Also, remove only 1” (2.5 cm) or 1/3 of the grass blade when cutting.

Adjustments

CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

See Operator's Manual for adjustment procedures for the cutting units on the Groundsmaster 4000−D.

Castor Wheel Tire Pressure

Castor tires on the front and side decks should be inflated to 50 psi (3.5 bar).

Blade Stopping Time

The blades of the cutting deck are to come to a complete stop in approximately 5 seconds after the cutting deck engagement switch is shut down.

NOTE: Make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify this stopping time, have a second person stand back from the deck at least 20 feet and watch the blades on one of the cutting decks. Have the operator shut the cutting decks down and record the time it takes for the blades to come to a complete stop. If this time is greater than 7 seconds, the braking valve on the hydraulic manifold needs adjustment.

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Service and Repairs

CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

Front Cutting Unit

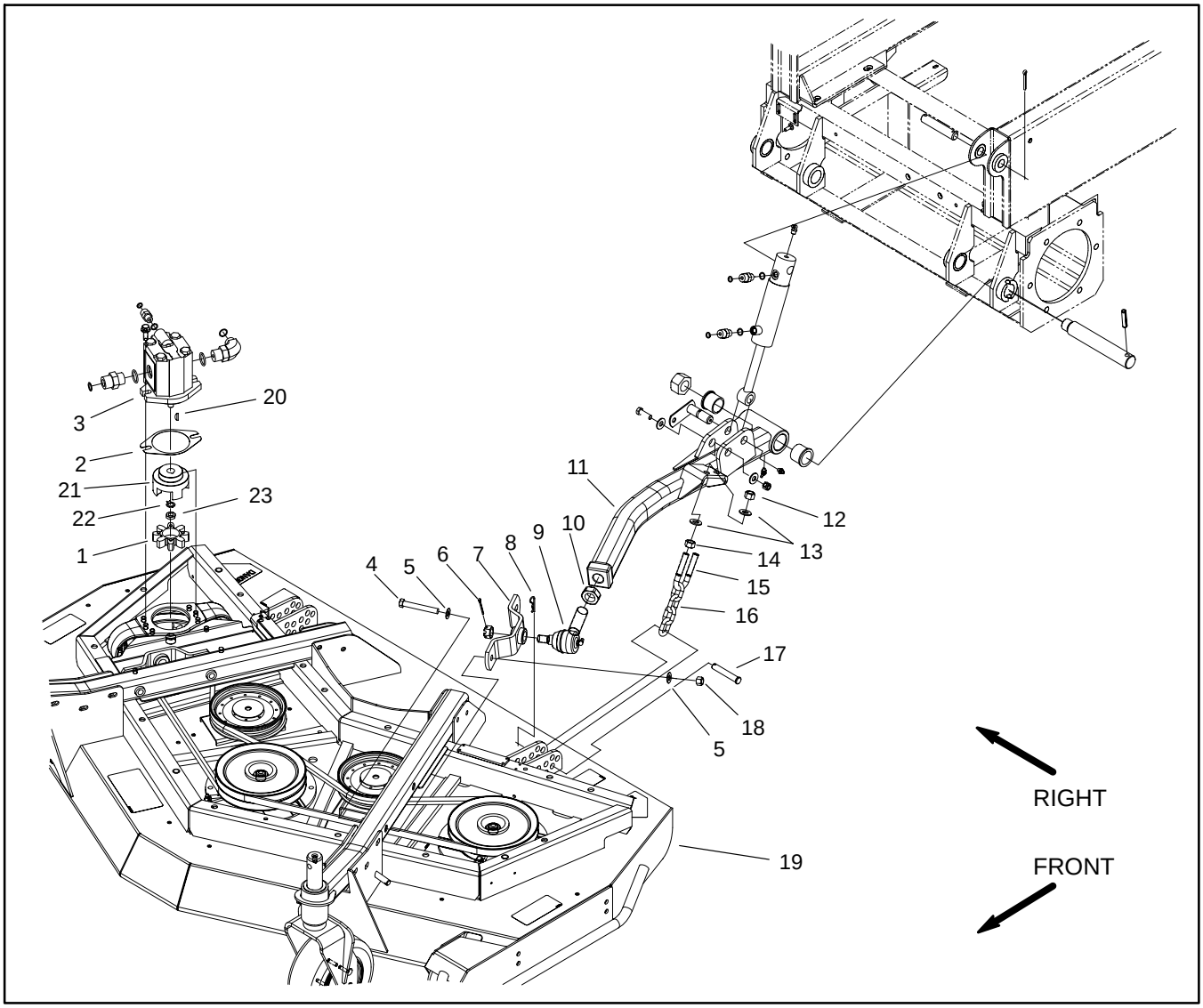

Figure 1

1. **Spider**
2. **Mounting shim (if required)**
3. **Hydraulic deck motor**
4. **Cap screw**
5. **Washer**
6. **Cotter pin**
7. **Ball joint mount**
8. **Hairpin**
9. **Ball joint**
10. **Jam nut**
11. **Lift arm (LH shown)**
12. **Lock nut**
13. **Flat washer**
14. **Nut**
15. **U−bolt**
16. **Height−of−cut chain**
17. **Clevis pin**
18. **Lock nut**
19. **Front cutting deck**
20. **Woodruff key**
21. **Spider hub**
22. **Tab washer**
23. **Nut**

Removal

1. Position machine on a clean, level surface. Lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

NOTE: Removal of clevis pin from deck and height−of−cut chain is easier if deck is lifted slightly.

2. Remove hairpin and clevis pin that secure the height−of−cut chain to the rear of the cutting deck (Fig. 2).

3. Remove hydraulic motor from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 − Hydraulic Systems).

4. Remove cap screws, washers, and lock nuts securing ball joint mounts to front deck castor arms (Fig. 4).

5. Slide the cutting unit away from the traction unit.

Installation

1. Position machine on a clean, level surface. Lower lift arms, stop engine, engage parking brake, and remove key from the ignition switch.

2. Position the front deck to the lift arms.

3. Align ball joint mounts to front deck castor arms and secure with cap screws, washers, and lock nuts (Fig. 4).

NOTE: Installation of clevis pin to deck and height−of−cut chain is easier if deck is lifted slightly.

4. Install clevis pin and hairpin that secure the height−of−cut chain to the rear of the cutting deck (Fig. 2).

5. Install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 − Hydraulic Systems).

6. Lubricate grease fittings on cutting deck and lift assembly (see Operator's Manual).

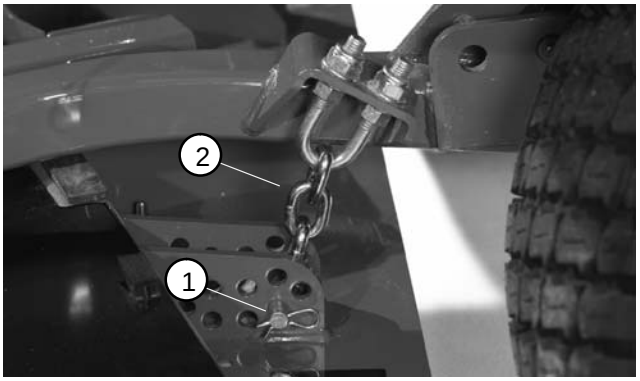

Figure 2

1. **Hairpin and clevis pin**
2. **Height−of−cut chain**

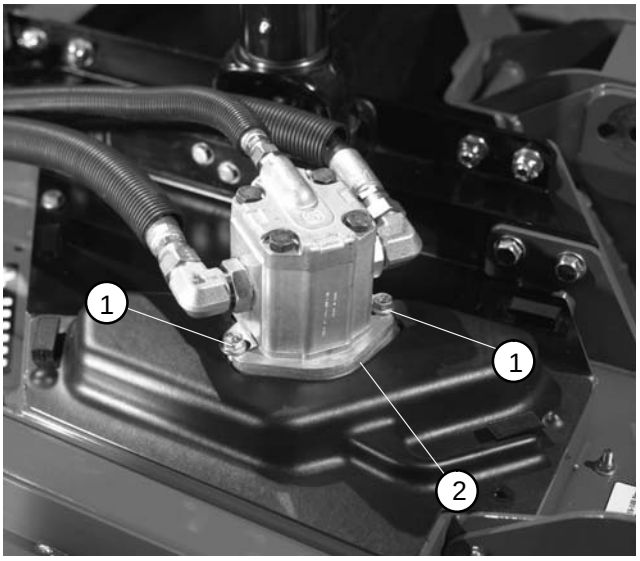

Figure 3

1. **Flange head screw**
2. **Hydraulic motor**

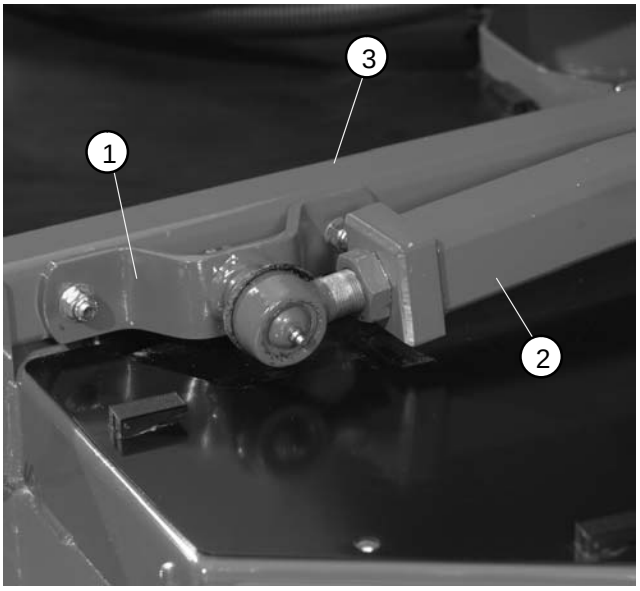

Figure 4

1. **Ball joint mount**
2. **Lift arm**
3. **Castor arm**

Side Cutting Unit

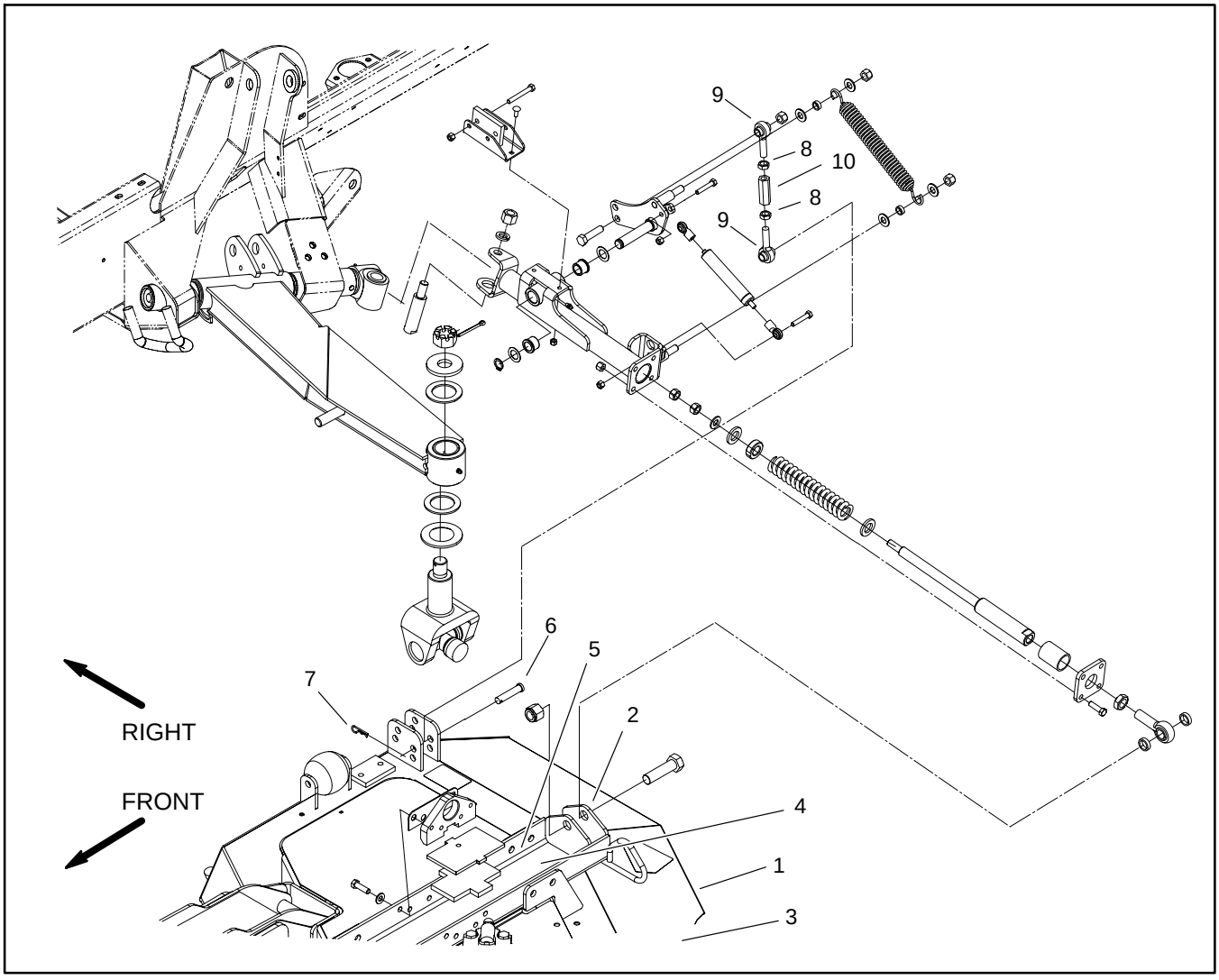

Figure 5

1. **Side cutting deck (LH shown)**
2. **Deck mount (LH shown)**
3. **Flange head screw**
4. **Flat washer**
5. **Lock nut**
6. **Clevis pin**
7. **Hair pin**
8. **Jam nut**
9. **Rod end**
10. **Damper link tube**

Removal

1. Position machine on a clean, level surface. Lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove hydraulic motor from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 − Hydraulic Systems).

IMPORTANT: Do not change the length of the damper link. The length of the damper link should be 5.370" ± .075" (13.6 cm ± .2 cm) measured between rod end centers.

3. Remove hairpin and clevis pin that secure the damper link to the rear of the cutting deck (Fig. 7).

4. Remove eight flange head screws, flat washers, and lock nuts that secure deck mount to cutting deck (Fig. 6).

5. Raise lift arm enough to separate deck mount from cutting deck.

6. Slide the cutting deck away from the traction unit.

Installation

1. Position machine on a clean, level surface. Stop engine, engage parking brake, and remove key from the ignition switch.

2. Position the side cutting deck to the lift arm.

3. Lower lift arm while aligning deck mount to cutting deck.

4. Install deck mount to cutting deck with eight flange head screws, flat washers, and lock nuts (Fig. 6). Tighten fasteners.

IMPORTANT: Do not change the length of the damper link. The length of the damper link should be 5.370" ± .075" (13.6 cm ± .2 cm) measured between rod end centers.

5. Install clevis pin and hairpin that secure the damper link to the rear of the cutting deck (Fig. 7).

6. Install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 − Hydraulic Systems).

7. Lubricate grease fittings on cutting deck and lift assembly (see Operator's Manual).

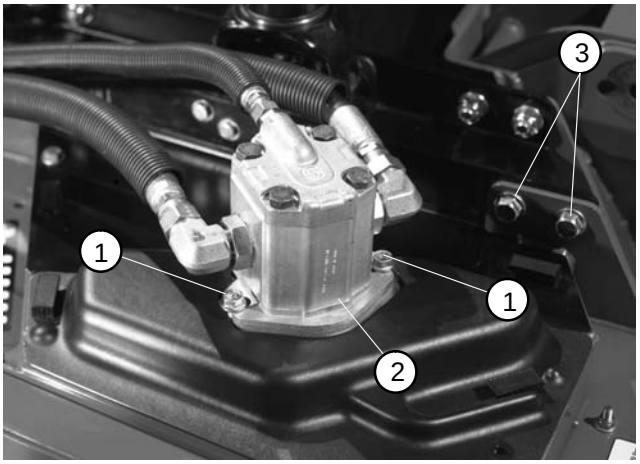

Figure 6

1. **Flange head screw**
2. **Hydraulic motor**
3. **Deck mount screw**

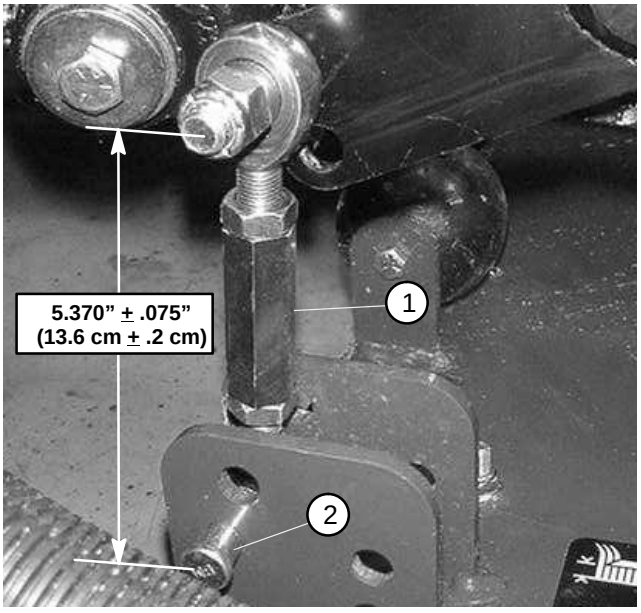

Figure 7

1. **Damper link**
2. **Clevis pin**

Blade Spindle Service

Disassembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove belt covers from top of cutting deck. Loosen idler pulley to release belt tension. Remove drive belt from spindle to be serviced.

3. If drive spindle is to be serviced, remove hydraulic motor from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 − Hydraulic Systems).

4. Start the engine and raise the cutting unit. Stop engine and remove key from the ignition switch. Latch or block up the cutting unit so it cannot fall accidentally. Front deck can be tilted for spindle service (see Operator's Manual).

5. Remove cutting blade, anti−scalp cup and bolt from spindle to be serviced (see Operator's Manual).

6. For drive spindle assemblies (Fig. 8), remove flange head screws that secure spindle to deck. Remove spindle housing assembly with motor mount from deck.

7. For driven spindle assemblies, remove flange head screws and lock nuts that secure spindle to deck. Remove spindle housing assembly from the deck.

NOTE: Early production spindle assemblies included a v−ring seal which has been found to be unnecessary. Discard v−ring seal if found in spindle assembly.

8. Loosen and remove lock nut from top of spindle shaft. Remove washer, pulley, and v−ring seal (if equipped) from spindle. For drive spindle, remove motor mount.

9. Remove the spindle shaft from the spindle housing which may require the use of an arbor press. The spacer should remain on the spindle shaft as the shaft is being removed.

10. Remove seals from spindle housing.

11. Allow the bearings, inner spacer and spacer ring to drop out of the spindle housing.

12. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Remove the large outer spacer from the housing.

13. The large snap ring can remain inside the spindle housing. Removal of snap ring is very difficult.

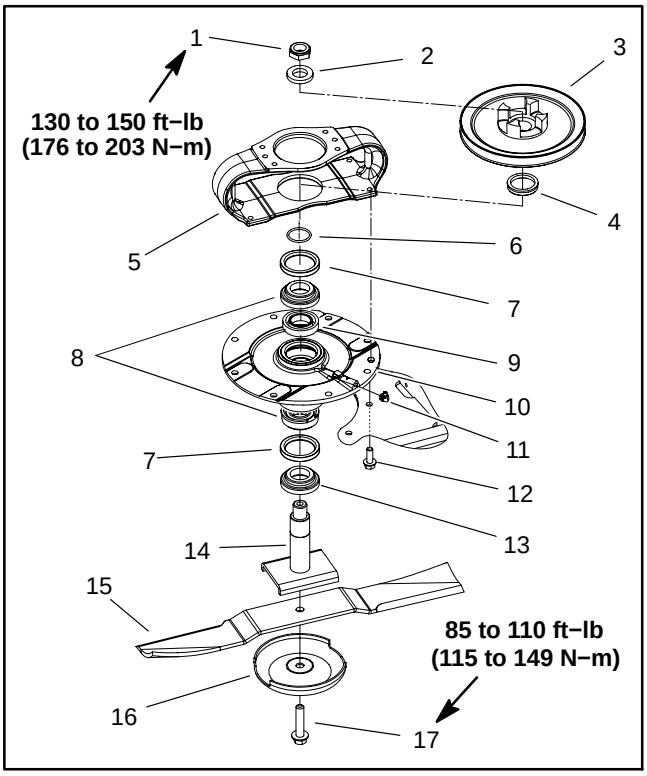

Figure 8

1. **Lock nut**
2. **Washer**
3. **Pulley (drive shown)**
4. **V−ring seal (if equipped)**
5. **Motor mount**
6. **O−ring (if equipped)**
7. **Oil seal**
8. **Bearing set**
9. **Spacer set (2 piece)**
10. **Spindle housing**
11. **Grease fitting**
12. **Flange head screw**
13. **Spacer**
14. **Spindle shaft**
15. **Blade**
16. **Anti−scalp cup**
17. **Blade bolt**

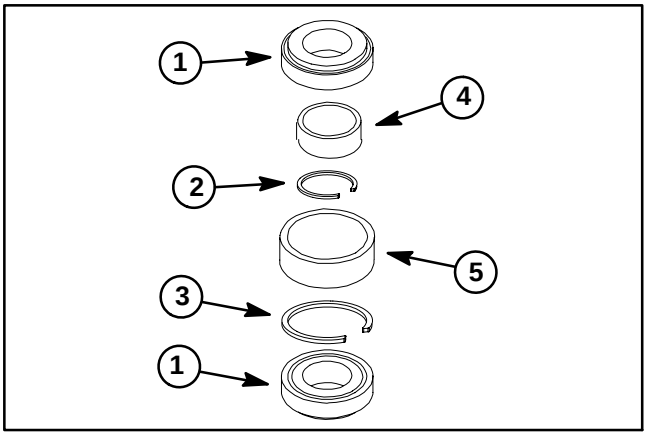

Figure 9

1. **Bearing**
2. **Spacer ring**
3. **Large snap ring**
4. **Inner spacer**
5. **Outer spacer**

Assembly

IMPORTANT: If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring. Replacement bearings are sold only with a matched spacer ring and large snap ring (Fig. 9). These parts cannot be purchased separately.

1. If large snap ring was removed, install snap ring into spindle housing groove. Make sure snap ring is seated in groove.

2. Install large outer spacer into top of spindle housing. The spacer should fit against the snap ring.

3. Using an arbor press, push the bearing cups into the top and bottom of spindle housing. The top bearing cup must contact the spacer previously installed, and the bottom bearing cup must contact the snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second against it (Fig 10).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals and o−ring.

5. Install lower bearing and seal into bottom of spindle housing. **Note:** The bottom seal must have the lip facing out (down) (Fig. 11).

IMPORTANT: If bearings are being replaced, make sure to use the spacer ring that is included in bearing set (Fig. 9).

6. Slide spacer ring and inner spacer into spindle housing, then install upper bearing and seal into top of housing. **Note:** The upper seal must have the lip facing in (down) and be recessed into the spindle housing .095” (2.4 mm) (Fig. 11).

7. Inspect the spindle shaft and spindle spacer to make sure they are free of burrs or nicks that could possibly damage the seals. Lubricate the shaft with grease.

8. Install spindle spacer onto shaft. Carefully slide spindle shaft up through spindle housing. The bottom seal and spindle spacer fit together when the spindle is installed fully. Install o−ring (if equipped) onto spindle shaft.

9. For drive spindle, position motor mount to top of spindle assembly.

NOTE: Early production spindle assemblies included a v−ring seal which has been found to be unnecessary. **Do not** install a v−ring seal when assembling the spindle.

10. Install pulley (hub down), washer, and lock nut to spindle shaft. Tighten lock nut from 130 to 150 ft−lb (176 to 203 N−m).

IMPORTANT: Pneumatic grease guns can produce air pockets when filling large cavities and therefore, are not recommended to be used for proper greasing of spindle housings.

11. Attach a hand pump grease gun to grease fitting and fill housing cavity with grease until grease starts to come out of lower seal.

12. Rotate spindle shaft to make sure that it turns freely.

13. Secure drive spindle assembly to deck with flange head screws. Driven spindle assemblies are attached to the deck with flange head screws and flange lock nuts.

14. Install cutting blade, anti−scalp cup and bolt (see Operator’s Manual). Tighten blade bolt from 85 to 110 ft−lb (115 to 149 N−m).

15. Install drive belt and adjust belt tension (see Operator’s Manual).

16. If drive spindle was removed, install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 − Hydraulic Systems). Install belt covers to cutting deck.

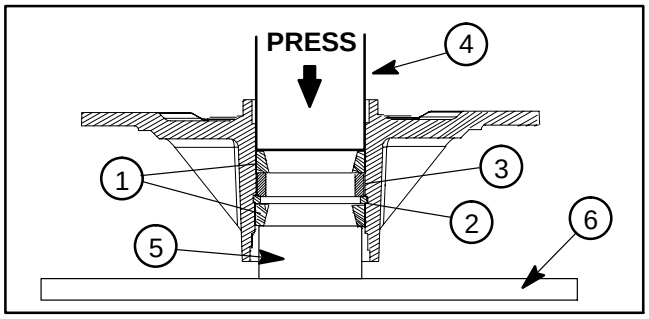

Figure 10

1. **Bearing cups**
2. **Large snap ring**
3. **Large spacer**
4. **Arbor press**
5. **Support**
6. **Arbor press base**

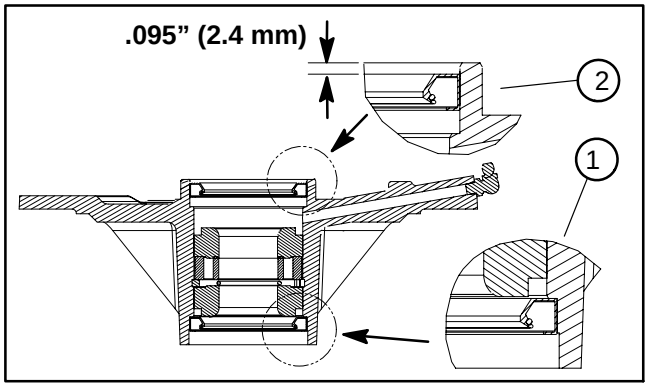

Figure 11

1. **Bottom seal installation**
2. **Upper seal installation**

Castor Forks and Wheels

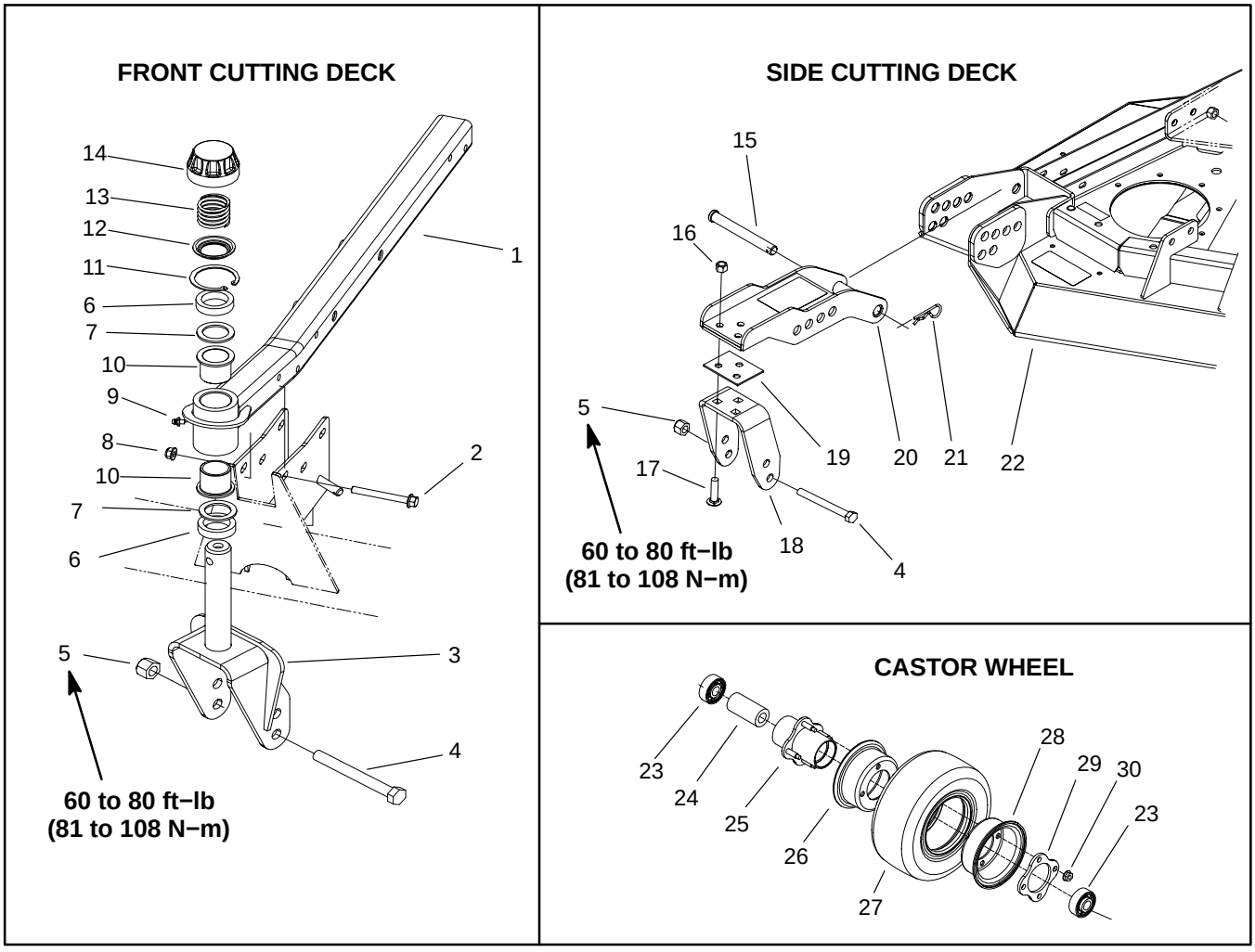

Figure 12

1. Castor arm (front deck)
2. Flange head screw
3. Castor fork
4. Cap screw
5. Lock nut
6. Castor spacer
7. Thrust washer
8. Flange lock nut
9. Grease fitting
10. Flange bushing
11. Retaining ring
12. Cap washer
13. Compression spring
14. Cap
15. Clevis pin
16. Lock nut
17. Carriage screw
18. Castor fork bracket
19. Shim
20. Castor bracket
21. Hairpin
22. Cutting deck (RH shown)
23. Bearing
24. Inner bearing spacer
25. Wheel hub
26. Wheel rim half
27. Castor tire
28. Wheel rim half
29. Plate
30. Flange nut

Disassembly

1. Disassemble castor wheel using Figure 12 as a guide.

Reassembly

1. Assemble castor wheel using Figure 12 as a guide.

2. Torque castor wheel lock nut from 60 to 80 ft−lb (81 to 108 N−m).

Chapter 9

Electrical Diagrams

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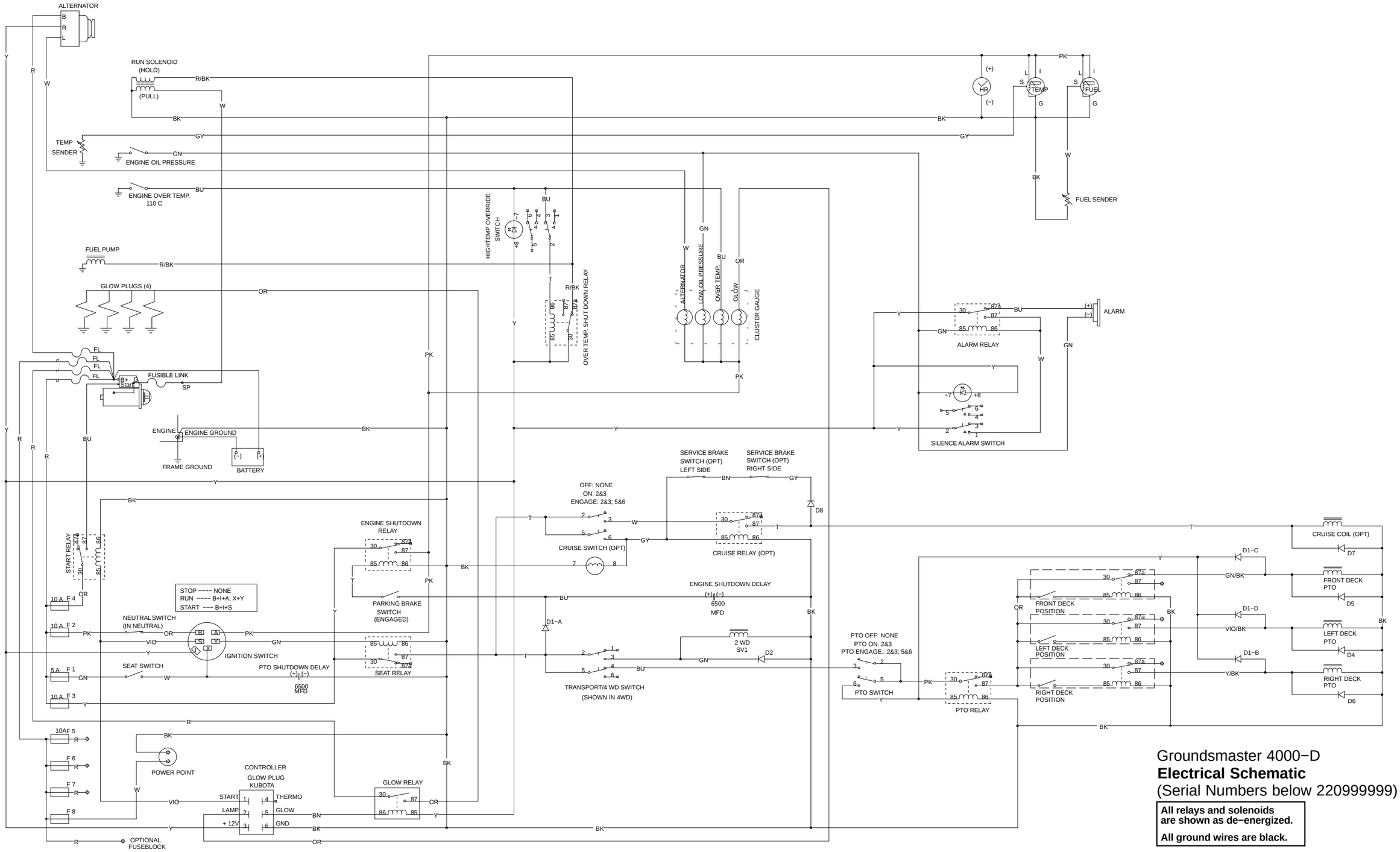
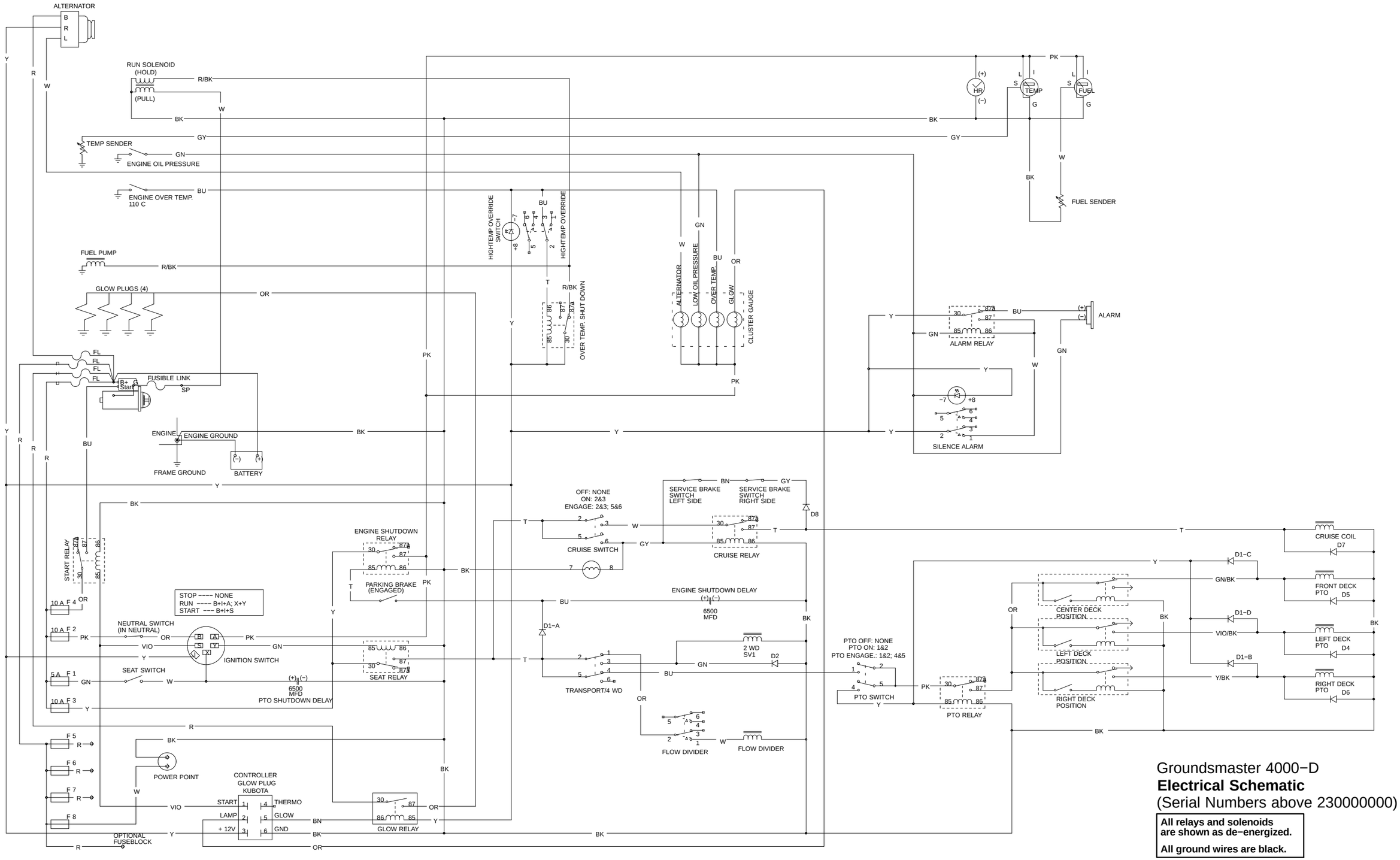


Groundsmaster 4000−D
Electrical Schematic
(Serial Numbers below 220999999)

All relays and solenoids are shown as de−energized.

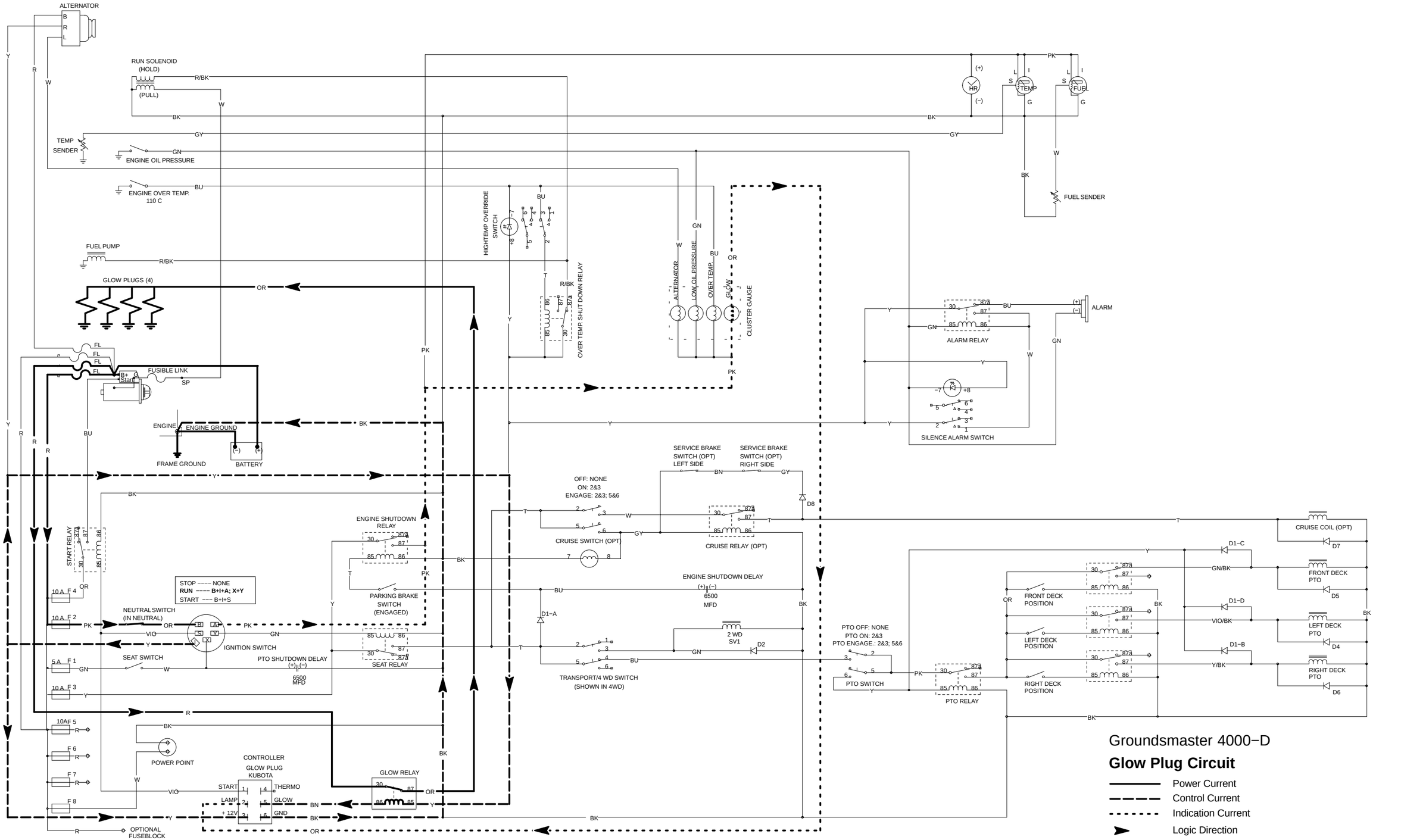
All ground wires are black.



Groundsmaster 4000−D
Electrical Schematic
(Serial Numbers above 230000000)

All relays and solenoids are shown as de−energized.

All ground wires are black.

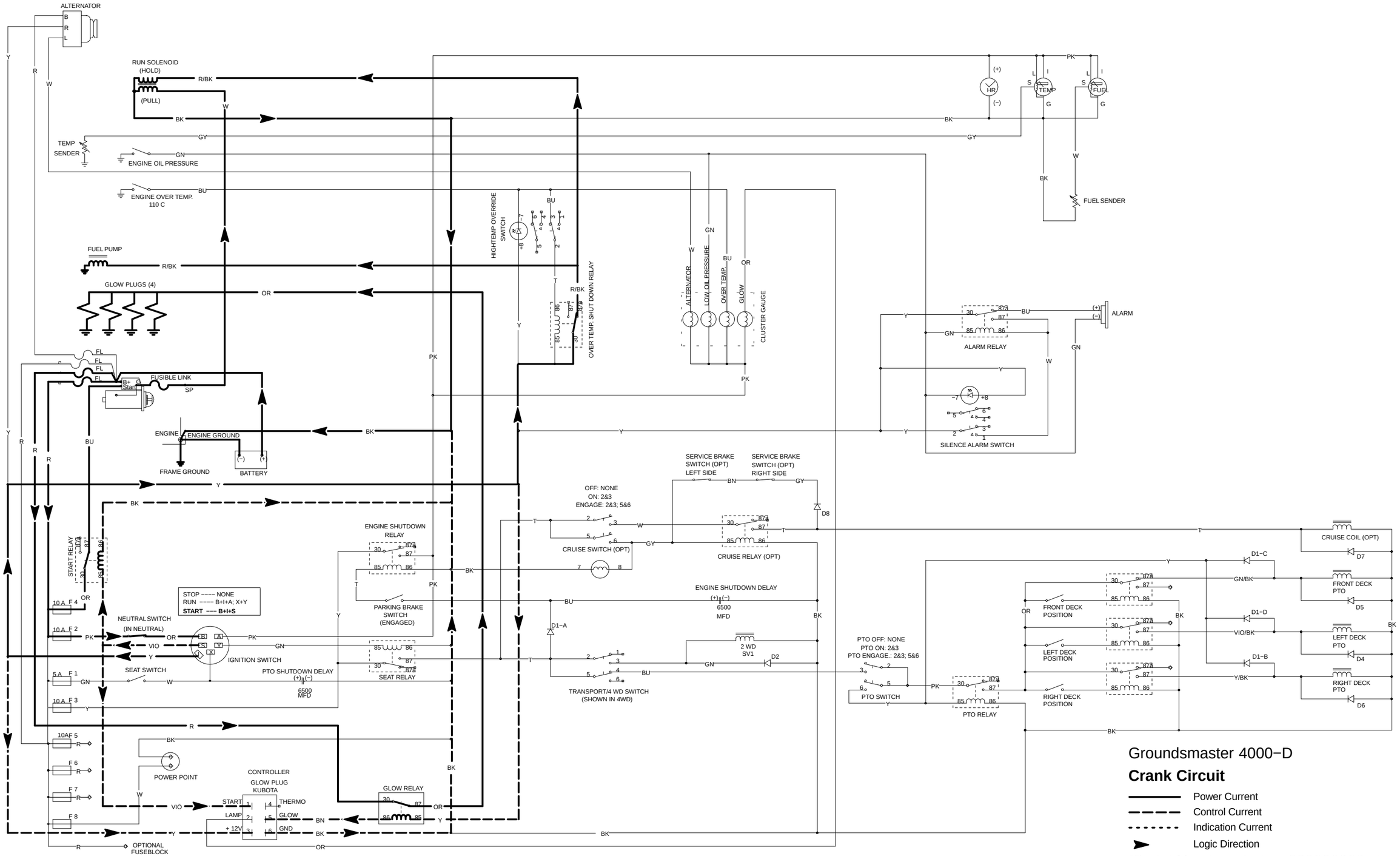


Groundsmaster 4000−D

Glow Plug Circuit

- Power Current
- Control Current
- Indication Current
- Logic Direction

(Serial Numbers below 220999999 shown)



Groundsmaster 4000−D

Crank Circuit

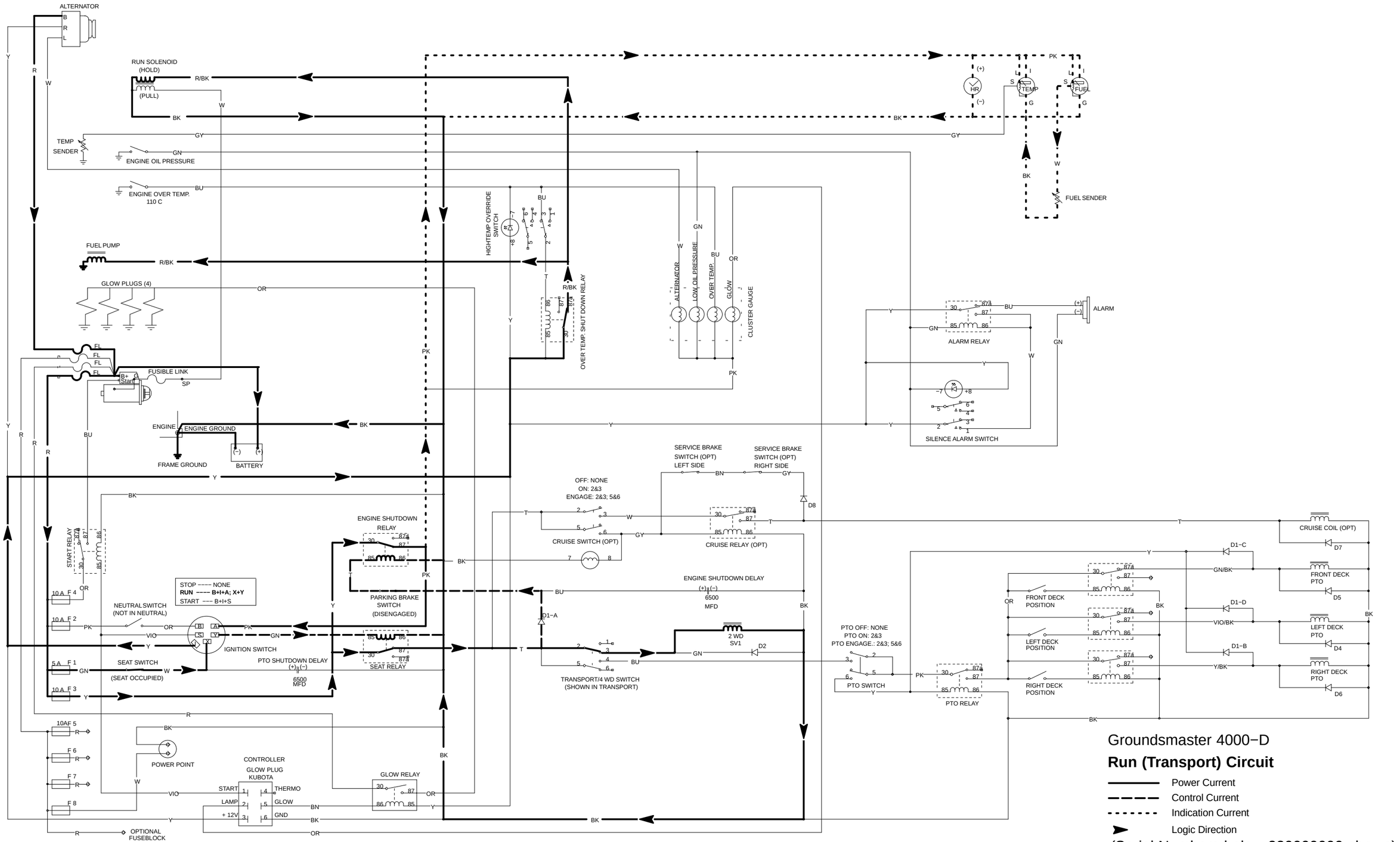
Power Current

Control Current

Indication Current

Logic Direction

(Serial Numbers below 220999999 shown)



Groundsmaster 4000−D

Run (Transport) Circuit

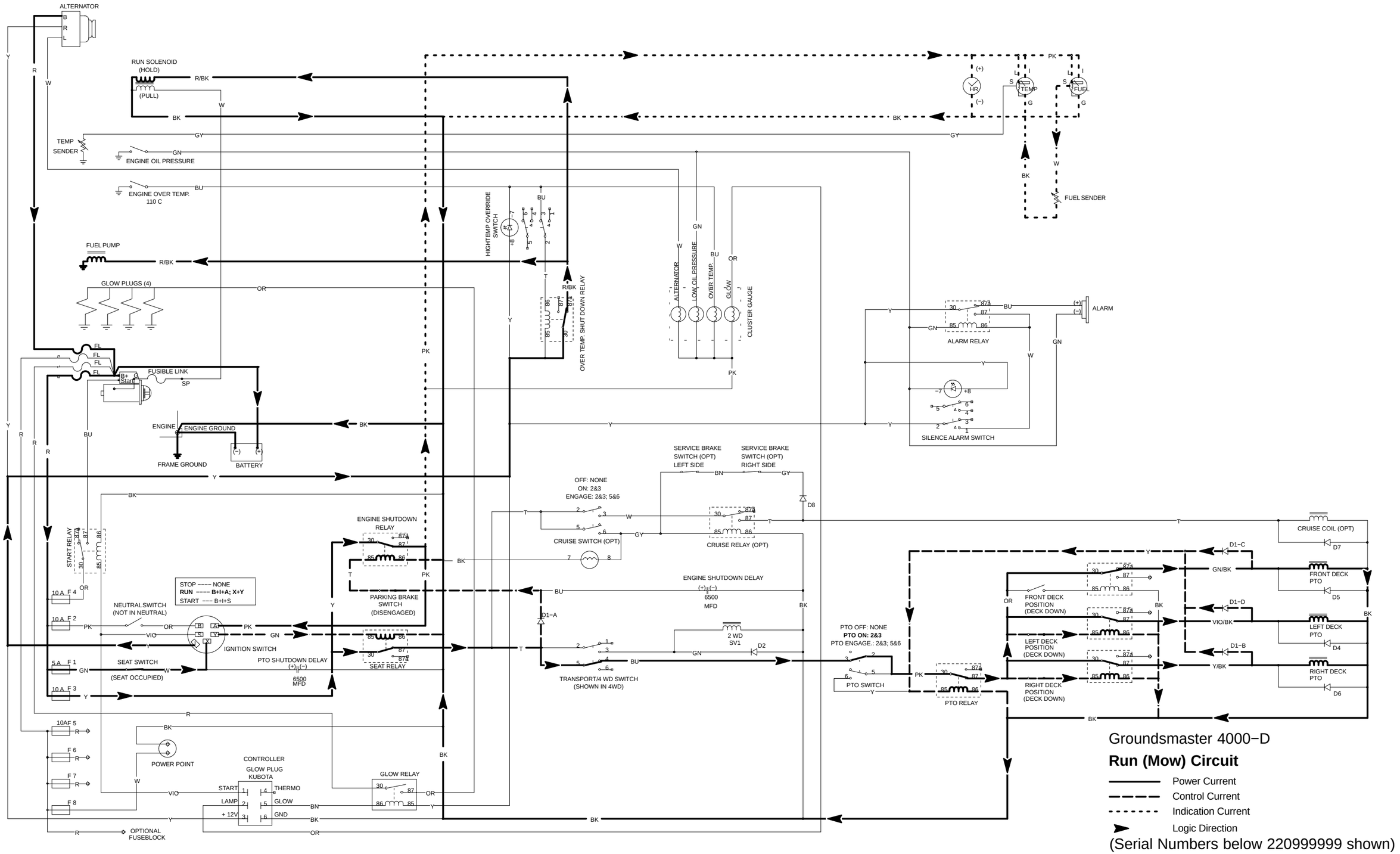
Power Current

Control Current

Indication Current

Logic Direction

(Serial Numbers below 220999999 shown)



Groundsmaster 4000−D

Run (Mow) Circuit

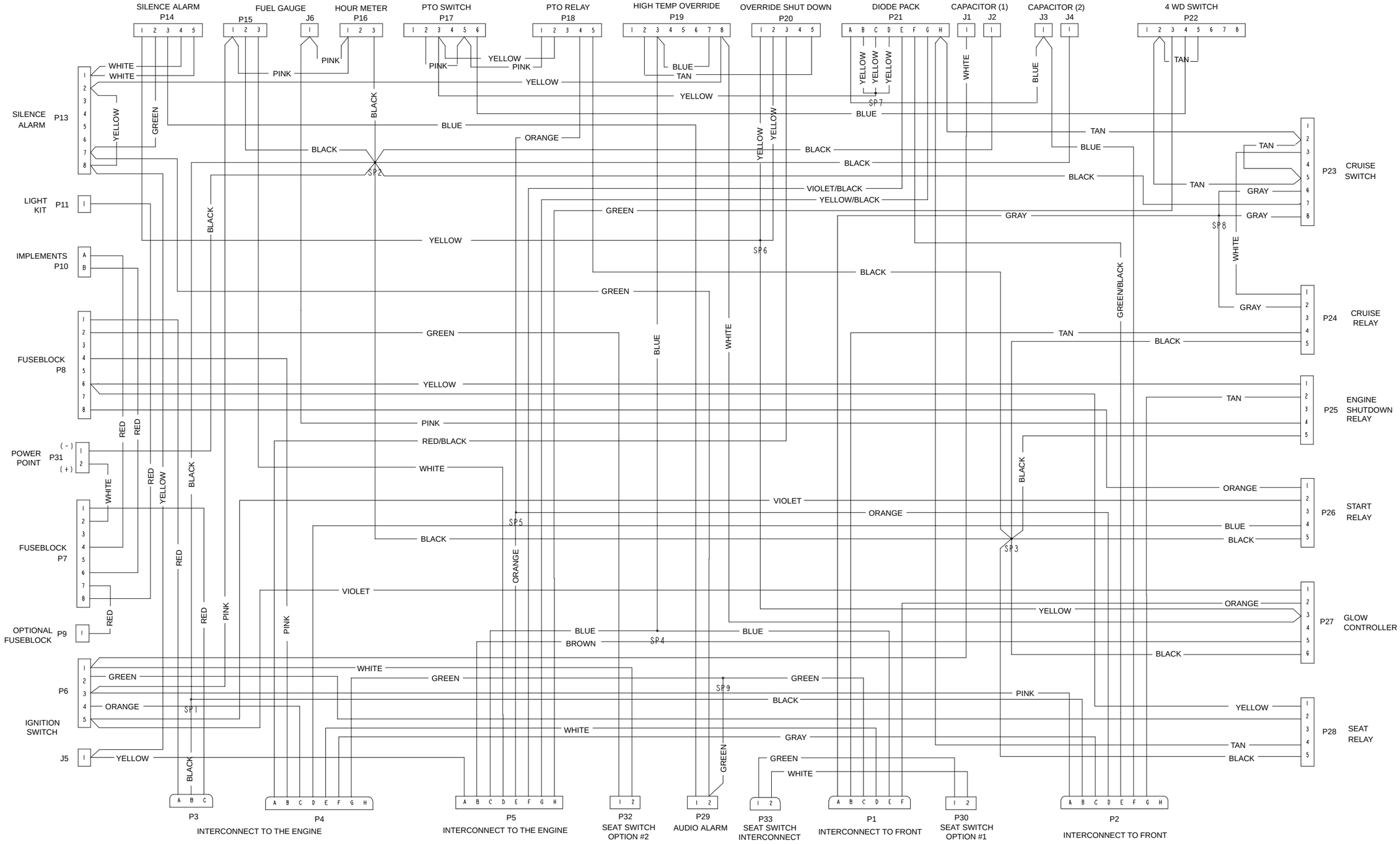
Power Current

Control Current

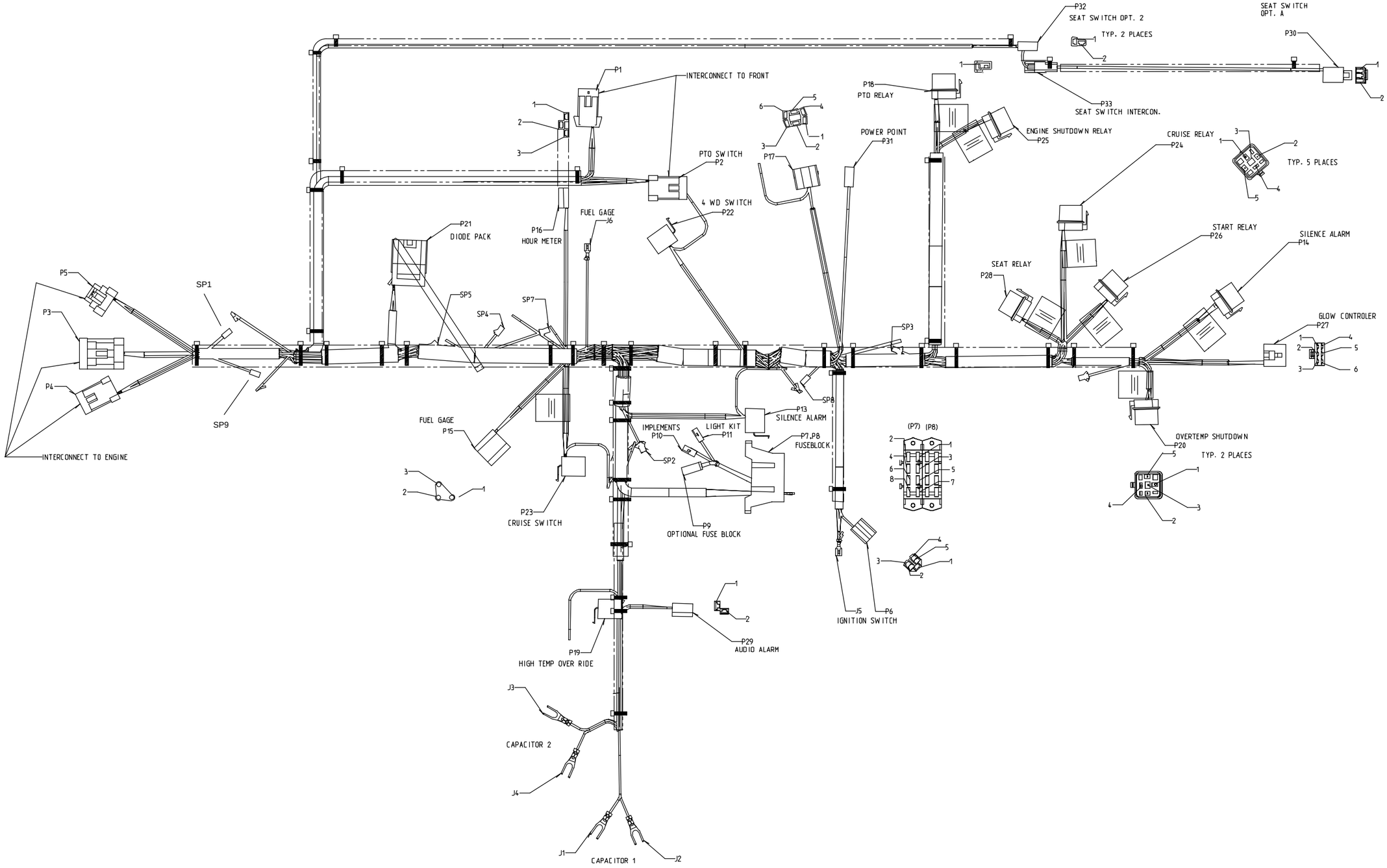
Indication Current

Logic Direction

(Serial Numbers below 220999999 shown)



Groundsmaster 4000−D
Main Wire Harness
(Serial Numbers below 220999999)



Groundsmaster 4000−D
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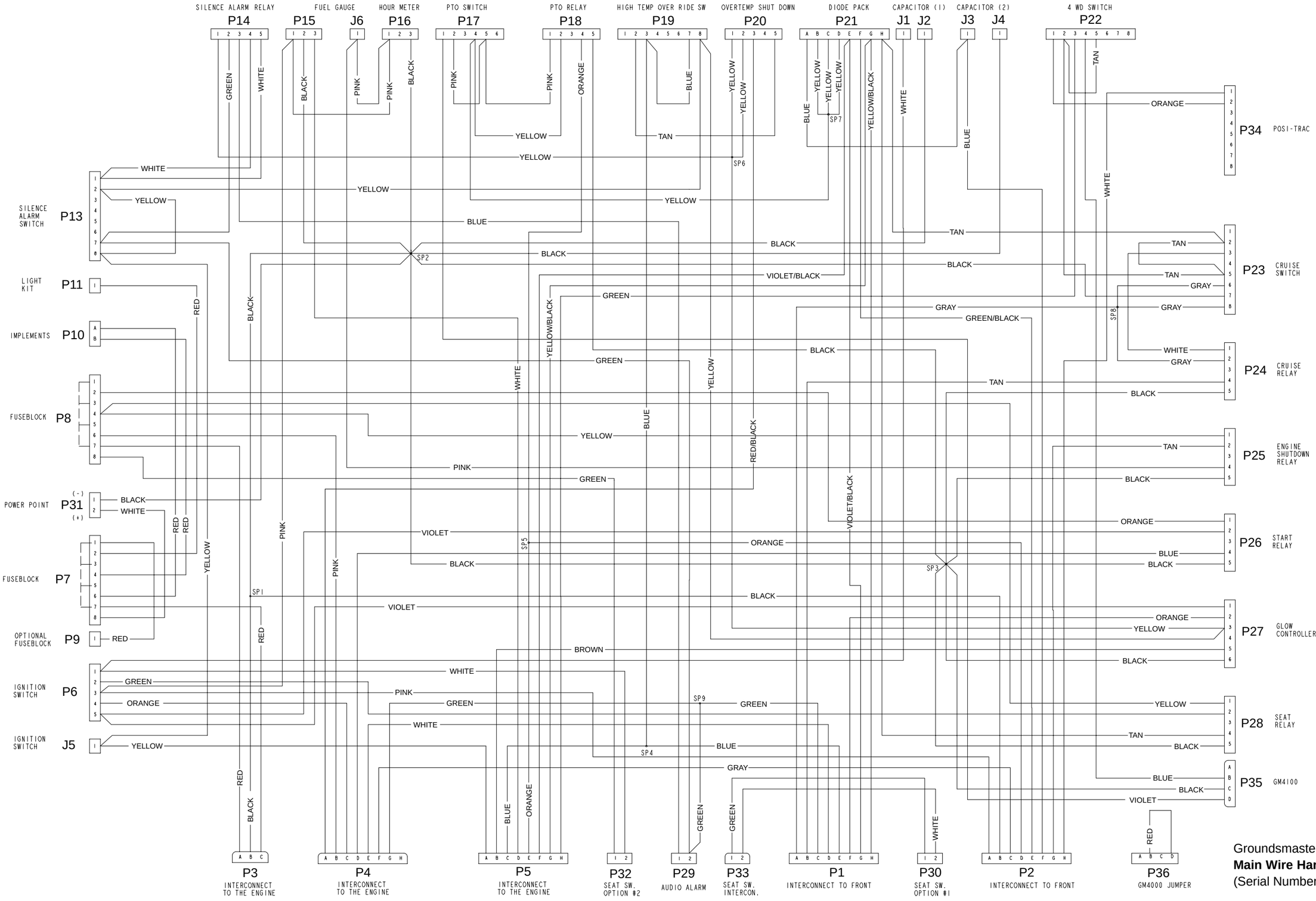

Groundsmaster 4000−D
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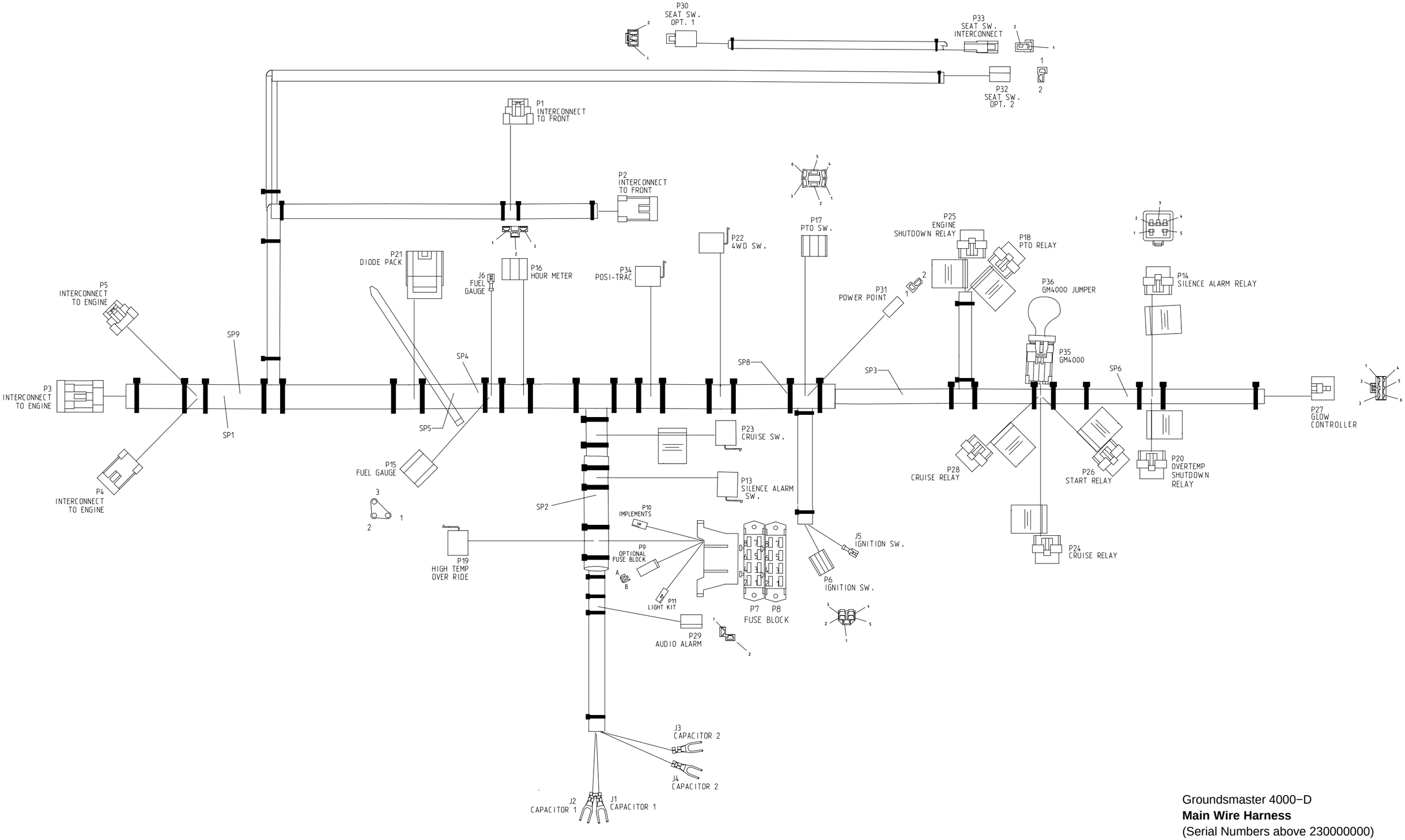

Groundsmaster 4000−D
Main Wire Harness
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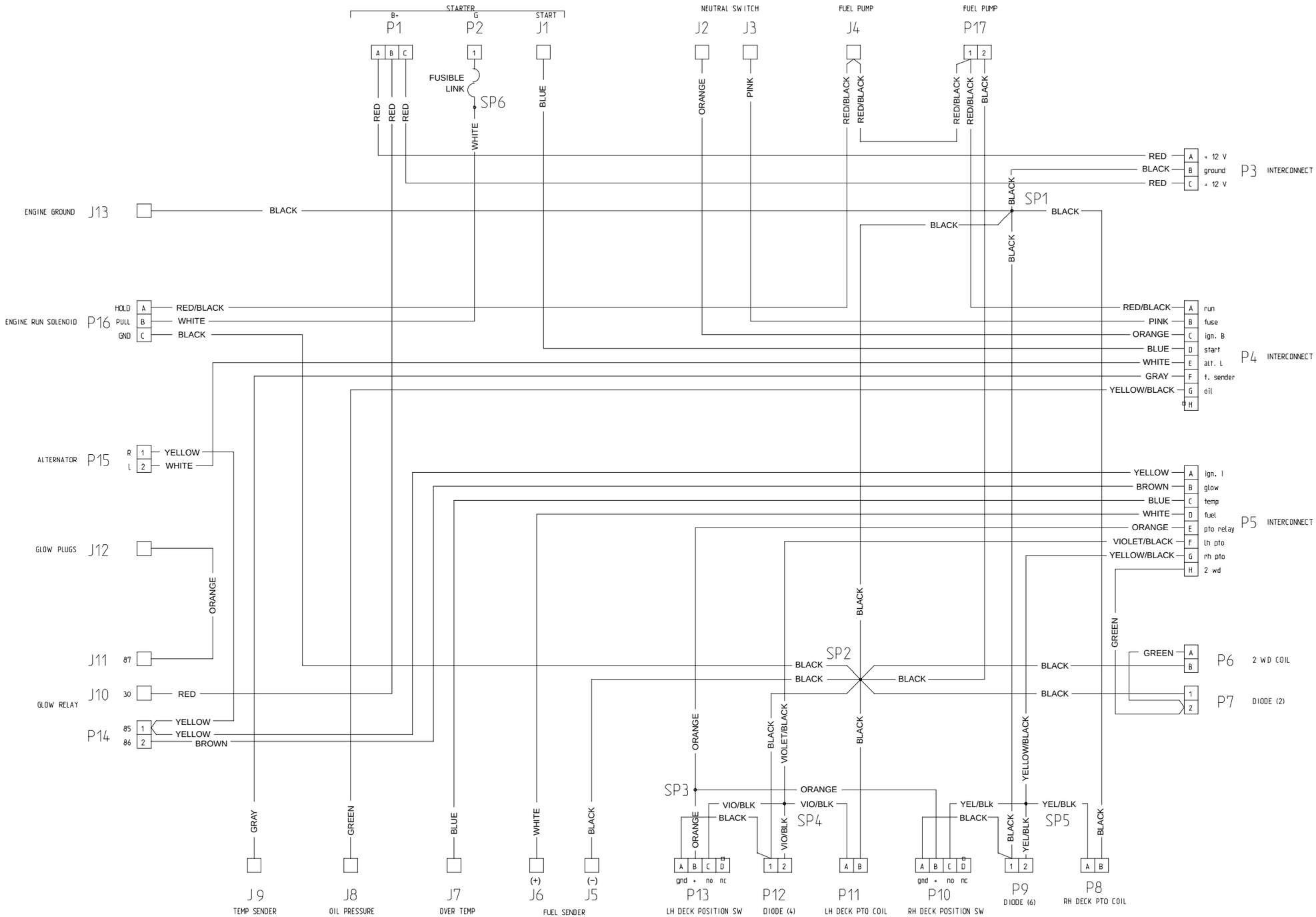
STARTER
B+
G
START
P1
P2
J1
NEUTRAL SWITCH
J2
J3
FUEL PUMP
J4
FUEL PUMP
P17
A B C
1
1 2
FUSIBLE LINK
SP6
RED
RED
RED
WHITE
BLUE
ORANGE
PINK
RED/BLACK
RED/BLACK
RED/BLACK
RED/BLACK
BLACK
RED
BLACK
RED
A + 12 V
B ground
C + 12 V
P3 INTERCONNECT
BLACK
SP1
BLACK
BLACK
BLACK
ENGINE GROUND
J13
BLACK
HOLD A
PULL B
GND C
ENGINE RUN SOLENOID
P16
RED/BLACK
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BLACK
RED/BLACK
PINK
ORANGE
BLUE
WHITE
GRAY
YELLOW/BLACK
A run
B fuse
C ign. B
D start
E alt. L
F t. sender
G oil
H
P4 INTERCONNECT
ALTERNATOR
P15
R 1
L 2
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WHITE
YELLOW
BROWN
BLUE
WHITE
ORANGE
VIOLET/BLACK
YELLOW/BLACK
A ign. I
B glow
C temp
D fuel
E pto relay
F lh pto
G rh pto
H 2 wd
P5 INTERCONNECT
GLOW PLUGS
J12
ORANGE
J11
87
GLOW RELAY
J10
30
RED
85 1
86 2
YELLOW
YELLOW
BROWN
P14
BLACK
SP2
BLACK
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P6 2 WD COIL
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DIODE (4)
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LH DECK PTO COIL
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gnd + no nc
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RH DECK POSITION SW
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DIODE (6)
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P8
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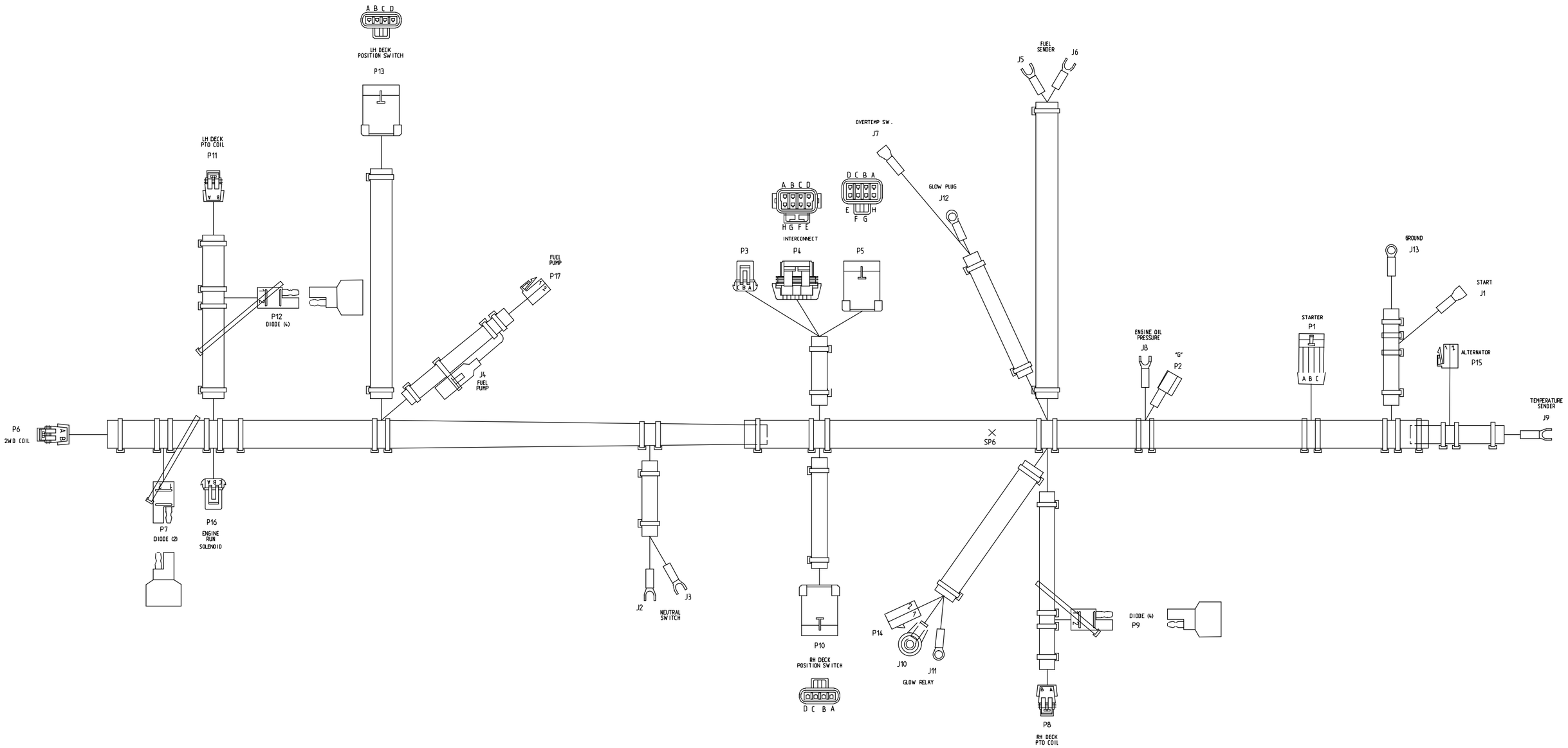
J5
FUEL SENDER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D C B A
E F G
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P5
OVERTEMP SW.
J7
GLOW PLUG
J12
FUEL
SENDER
J5
J6
ENGINE OIL
PRESSURE
J8
"G"
P2
STARTER
P1
A B C
GROUND
J13
START
J1
ALTERNATOR
P15
TEMPERATURE
SENDER
J9
P6
2WD COIL
SP6
P7
DIODE (2)
P16
ENGINE
RUN
SOLENOID
J2
J3
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SWITCH
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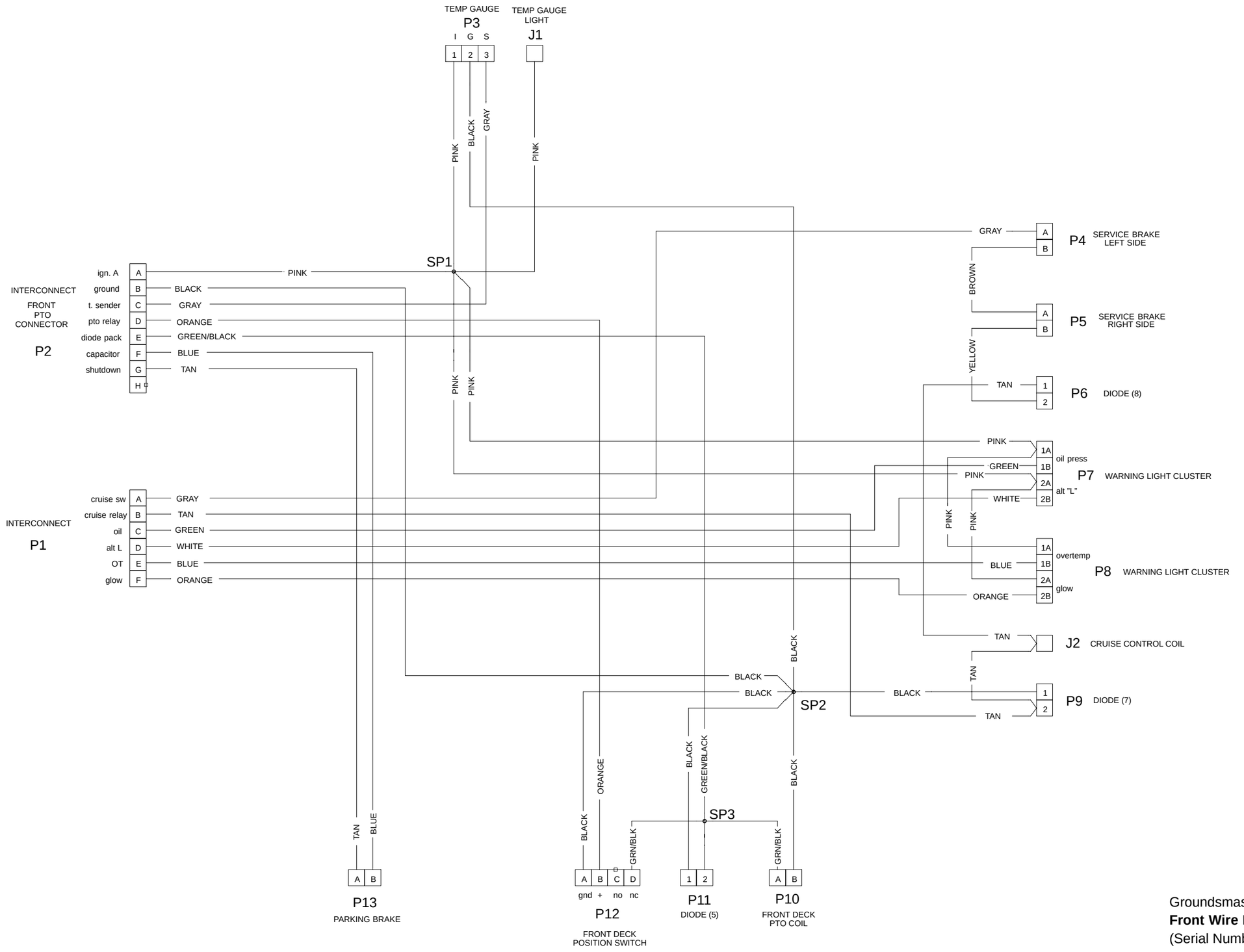
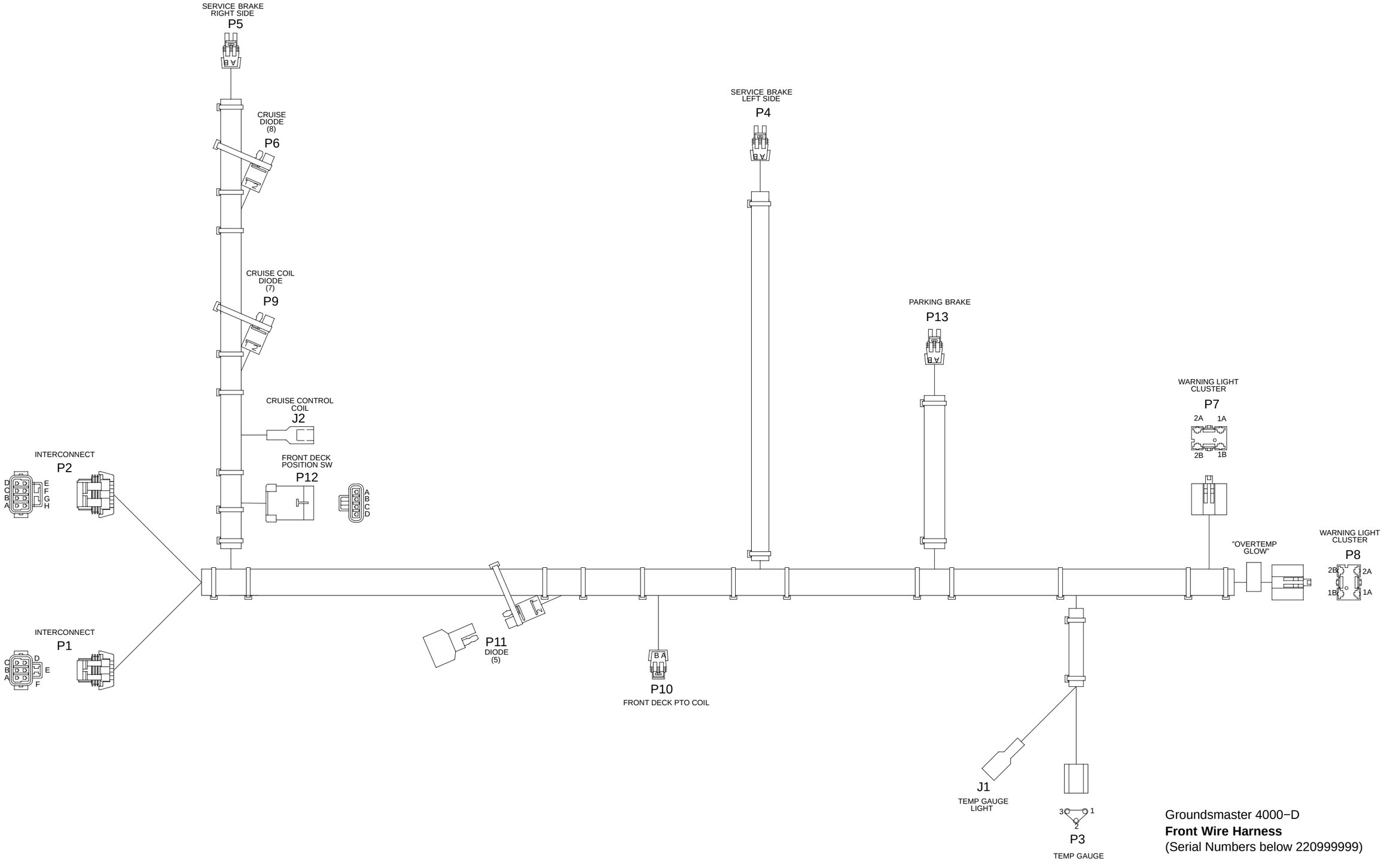


Groundsmaster 4000−D
Front Wire Harness
(Serial Numbers below 220999999)



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Front Wire Harness
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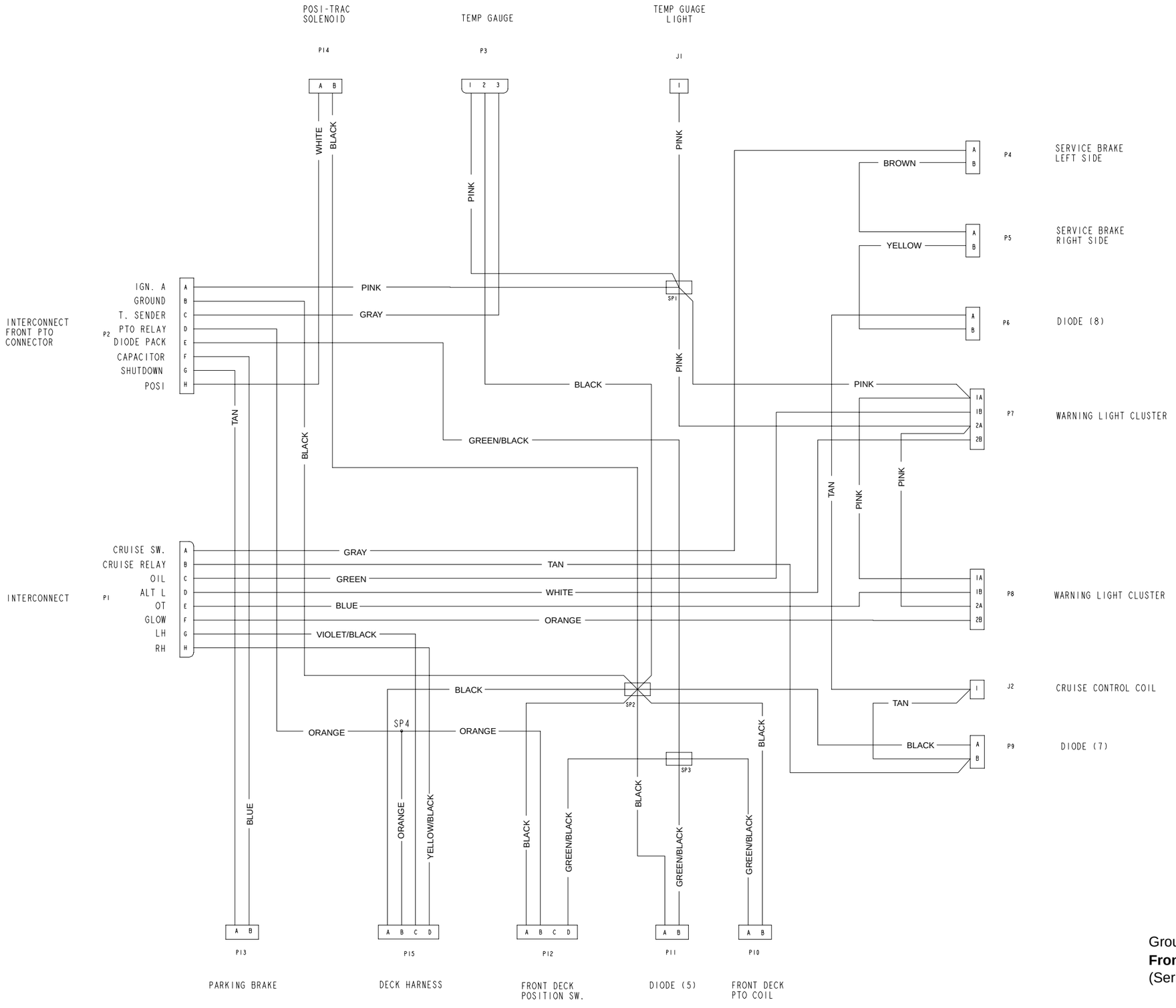

Groundsmaster 4000−D
Front Wire Harness
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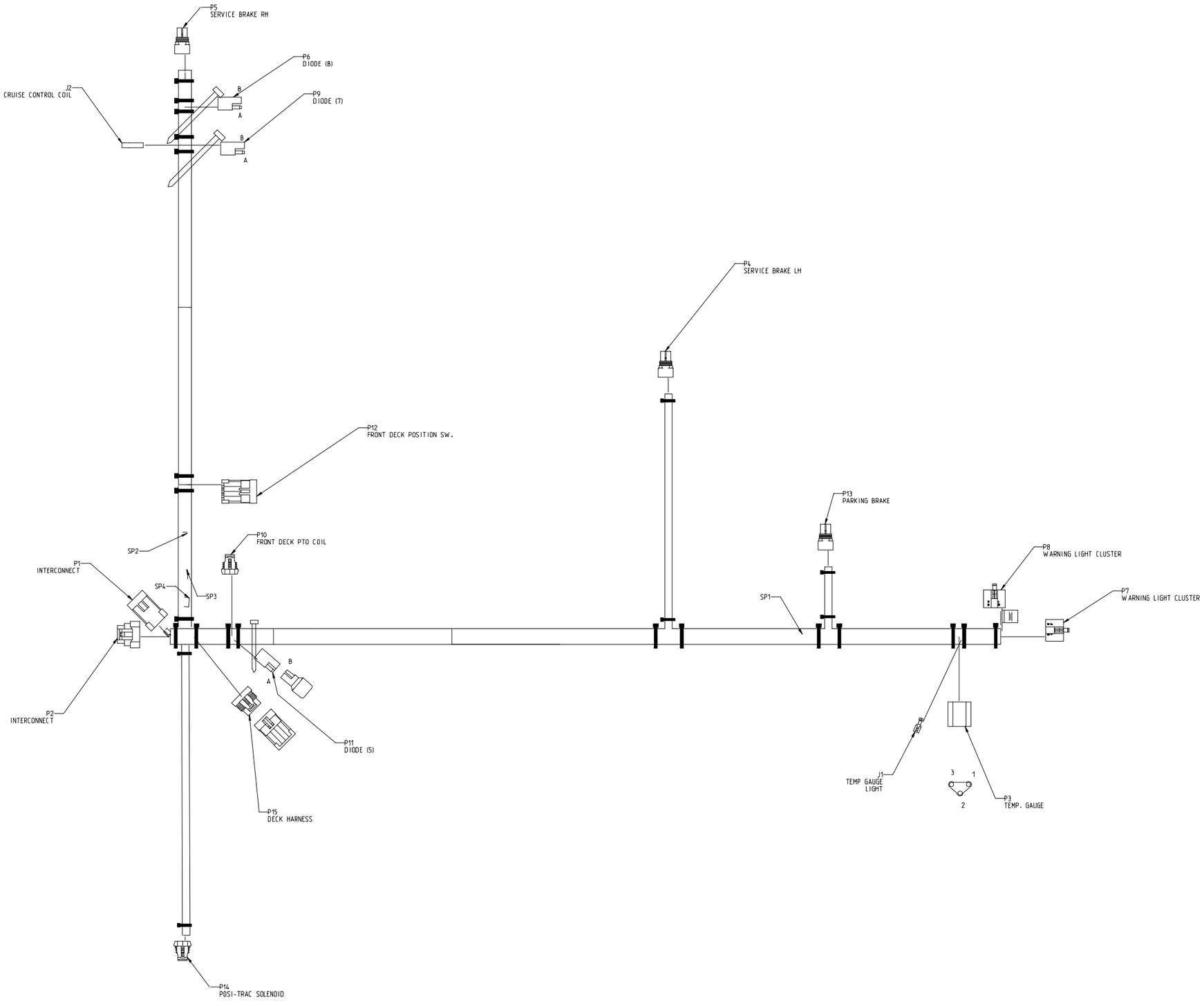

Groundsmaster 4000−D
Front Wire Harness
(Serial Numbers above 230000000)